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Institution of British Foundrymen.

ANNUAL CONFERENCE.

The seventeenth Annual Meeting of the Institution of British Foundrymen was held in the Royal Technical College, Glasgow, on Wednesday and Thursday, August 25 and 26, 1920.

Mr. John Little, Manchester, the retiring President, occupied the chair at the opening of the conference. He said it was interesting to recall that a matter of sixteen years ago the British Foundrymen's Association held a meeting in the same building. He had great pleasure in welcoming the representatives to the Conference. The attendance was perhaps not so large as they could have wished, but still it was sufficiently representative to ensure that a considerable measure of satisfaction would be derived from the meeting. He was particularly glad to observe that the audience included a member of the American Foundrymen's Association (Mr. H. Cole Estep), who was also a member of the Institution of British Foundrymen. Proceeding, Mr. Little remarked that since he addressed them in Liverpool twelve months ago they had passed through most troublous times in the country. The particular branch of engineering and industry they were interested in had experienced a bad time. He hoped that in their industry they had seen the worst of those troubles, and, personally, he felt they had. He believed the troubles associated with their industry had now run themselves almost to the far end. A better spirit and saner counsels appeared to be prevailing, and it looked as if they were now in for a far better time than appeared possible two or three years ago.

Report and Balance Sheet.

The Report of the Council and the balance-sheet were taken as read.

The Council's Report was in the following terms:—

The General Council has pleasure in presenting to the members the following Report of the progress and work of the Institution during the past Session, 1919-1920. Seven General Council meetings have been held during the session at Liverpool, Birmingham, Derby, Manchester, London, York, and Sheffield respectively, members attending from all parts of the country and representing all the Branches.

The work of the Branches has made steady progress, and the membership has increased considerably, due chiefly to the energies of the Branch Officers. The formation of a projected Branch in Liverpool is at present in abeyance, but steps are being taken to open a Branch in the Leeds and Bradford district, with headquarters at Bradford. It is hoped that the latter will be active during the forthcoming session.

The respective Branches have the following members attached:—

	Members.	Associate Members.	Associates.	Total.
Birmingham ...	56 (47)	105 (101)	39 (41)	200 (189)
Coventry ...	31 (18)	130 (117)	93 (91)	254 (226)
East Midlands...	25 (27)	44 (48)	9 (17)	78 (92)
Lancashire ...	80 (65)	126 (130)	6 (24)	212 (222)
London	73 (68)	50 (61)	7 (9)	130 (138)
Newcastle-on-Tyne	60 (45)	74 (70)	34 (37)	168 (152)
Peterborough ...	11 (7)	30 (33)	11 (21)	52 (61)
Scottish	56 (57)	140 (114)	78 (55)	274 (226)
Sheffield	84 (66)	93 (102)	7 (12)	184 (180)
Unattached ...	35 (29)	16 (29)	—	51 (58)
Totals ...	511(432)	808 (805)	284(307)	1603(1544)

The figures in brackets are those for the Session 1918–1919.

Further to the above, there are 22 Members, 50 Associate Members, and 138 Associates, whose election has been confirmed but who have not yet paid their subscriptions. Excluding the latter, the total number of Members on the Roll of the Institution was 1,603 on June 30, 1920, showing an increase for the session of 59. There are further elections by the Branches awaiting confirmation of the General Council. Ten deaths have been recorded. Sixteen Members, 44 Associate Members, and 22 Associates have resigned or ceased to become Members through lapsed subscriptions.

The Members of the General Council who are retiring in accordance with the rules are Messrs. J. Shaw, H. L. Reason, J. Oswald and H. Jewson. These gentlemen are eligible for re-election. Owing to the pressure of other duties, the General Secretary, Mr. Alexander Hayes, has been compelled to relinquish office, and the Council has unanimously selected Mr. W. G. Hollinworth to fill the position of General Secretary.

During the year two Special General Meetings of the Members were held to formally approve and confirm the resolution passed at the last General Meeting, whereby the title of the British Foundrymen's Association was changed to the Institution of British Foundrymen. This change has been duly registered.

A central office for the general secretary of the Institution has been opened at Bessemer House, Adelphi, London, W.C.2, at which all headquarters work is being conducted.

Mr. H. L. Reason has been appointed to represent the Institution on the newly-formed British Grey and Malleable Cast Iron Research Association, and a report of the Institution's activities with this work will be issued in due course.

A sub-committee, composed of Messrs. J. Little

(president), F. J. Cook (past president), M. Riddell, O. Stubbs (vice-presidents), and H. L. Reason, was appointed by the Council to consider and report on the secretarial duties and the organisation of the Institution. This sub-committee has reported that it advises various alterations, and its recommendations are embodied in the revised rules of the Institution which the Council will submit to the members for approval at the Annual General Meeting in Glasgow. The revisions aim at more effective control by the Branches over purely Branch affairs.

The movement for the obtaining of a Royal Charter for the Institution has been temporarily delayed by matters of minor detail, but will be completed at an early date.

The income and expenditure of the Institution have been under the careful consideration of the Council for some time past, and the Council feels compelled to recommend that the rates of subscriptions be raised to meet the greatly increased cost involved in conducting the work of the Institution. This increased cost is common to all similar institutions, many of which have also been compelled to raise their fees. The suggested new rates embodied in the proposed new rules comprise :—Members, £2 2s.; Associate Members, £1 1s.; Associates, 10s. 6d. A new form of subscription is also suggested, viz., subscribing firms, £5 5s. per annum.

The accounts and balance-sheet of the Institution for the year ended December 31, 1919, are presented herewith :—

INCOME AND EXPENDITURE ACCOUNT

From January 1 to December 31, 1919.

EXPENDITURE.

	£ s. d.	£ s. d.
Postages		37 3 2½
Printing and stationery, including printing of Proceedings		505 11 6
Council, Finance and Annual Meeting expenses		14 14 0
Branch expenses, viz. :—		
Lancashire	30 11 2	
Birmingham	69 16 4	
Scottish	39 4 7	
Sheffield	35 5 2	
London	50 19 11½	
East Midlands	12 14 11	
Peterborough	23 5 7	
Newcastle	29 6 10	
Coventry	19 8 6	
		301 13 0½
Audit fee		10 10 0
Incidental expenses		37 19 4½
Salaries, Secretary and Clerk		101 0 0
Rent of Office		20 16 8
Income Tax		57 19 6
		£1087 7 3½

INCOME.

	£ s. d.
Subscriptions received	899 1 5
Sale of books, etc.	1 5 6
Interest on War Loan	21 6 10
Balance, being excess of expenditure over income	165 13 6½
	£1087 7 3½

BALANCE SHEET.

December 31, 1919.

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions paid in advance		57 10 6
Sundry creditors		391 4 0
Royal Charter Fund—		
Amount subscribed	402 16 0	
Less expenses	51 7 0	
		351 9 0
Surplus as at 31st December, 1918	541 3 5½	
Less excess of expenditure over income for year ended 31st Dec., 1919	165 13 6½	
		375 9 11
		£1175 13 5

ASSETS.

	£ s. d.	£ s. d.	£ s. d.
Cash in hands of Secretaries, viz. :—			
Lancashire	6 9 0		
Scottish	18 5 1		
East Midlands	26 8 9		
Peterborough	12 18 9		
Coventry	31 17 0		
General Secretary	214 6 0		
" " Petty Cash	4 14 2		
	314 18 9		
Less due to Newcastle Sec.	16 17 2		
" Birmingham	4 10 2		
" Sheffield	6 12 11		
" London	25 18 3		
" General	5 2 8		
	59 1 2		
		255 17 7	
London City and Midland Bank, Limited	65 11 9		
Ditto Royal Charter Account	351 9 0		
		417 0 0	
Furniture, fixtures and fittings	18 13 6		
Add additions	51 11 6		
		70 5 0	
Investment Account—			
War Loan at cost		432 10 1	
		£1175 13 5	

ALEXANDER HAYES,
Gen. Secretary.

F. W. FINCH,
Hon. Treasurer.

We have examined the above balance sheet with the books and vouchers of the Institution, and find same to be in accordance therewith.

FRANK CREKE, HARCOURT & CO.,
Auditors,
23, Colmore Row, Birmingham.

July 26, 1920.

MR. VICKERS, Birmingham, said he thought the second item on the expenditure side of the balance-sheet was much too high, namely, £505 11s. 6d. for printing and stationery, including the printing of Proceedings. Then he further noticed that a sum of £57 19s. 6d. had been expended in respect of income-tax. He could not understand why this Institution should be the only technical organisation which was called upon to pay income-tax. To his mind it was not at all satisfactory that the income during the year should have been some £20 less than the sum actually expended. It did seem to him, furthermore, that a few of the Branches had been incurring what he would describe as a somewhat extraordinary measure of expenditure. For example, although the London Branch showed a drop in membership, its expenditure was the highest of all. On the other hand, the Scottish Branch, which had the largest membership, showed a drop in expenditure. In Scotland they appeared to be working their Branch at an expenditure of 1s. 6d per member. Then it was most interesting to note that the new Branch at Coventry was being worked on most economical lines.

THE CHAIRMAN said he was rather in the unfortunate position that he did not know a great deal about this question of the income-tax. Mr. Hayes, the late general secretary of the Institution, had probably to do with the matter, but he was not with them that day.

MR. T. H. FIRTH, Sheffield, said he quite agreed with what Mr. Vickers had said. He could not at all understand why the Institution of British Foundrymen should be in the position of being called upon to pay income-tax.

THE CHAIRMAN said that, in view of the discussion and the proposition made, the Council would take the subject up at once with the authorities.

MR. F. J. COOK, West Bromwich, said he quite agreed with Mr. Vickers that the Branches should

be enjoined to practise economy in their disbursements. The costs for printing looked high, but it was to be kept in view that it represented the charges for printing for two years, and not one only.

THE CHAIRMAN said the requisitions which came forward every month or every quarter from the Branches were most carefully scrutinised. The position was this, that the cost of practically everything had increased so tremendously, and the unfortunate thing was that the income had not risen in proportion to the expenditure.

MR. F. J. COOK moved, and MR. H. JEWSON, East Dereham, seconded the proposition that the Council's report and the statement of accounts be adopted. The proposition was put to the meeting and carried unanimously. It was further agreed that representations should be made to the Revenue authorities for a refundment of the moneys paid in respect of income-tax.

Election of New President.

THE PRESIDENT (Mr. John Little), having declared all offices vacant, proceeded to propose Mr. M. Riddell, Etna Ironworks, Falkirk (senior vice-president), for the post of President. Mr. Riddell was known probably to all the members present, and in his loyalty to the Institution he stood second to none. His efforts had always been expended in the direction of furthering the interests of the Institution.

MR. OLIVER STUBBS, Manchester, seconded the nomination. In Scotland, he felt sure, no words of his were necessary to commend the new President.

The election of Mr. Riddell was agreed to unanimously.

Interesting Presentations.

MR. LITTLE said that before he vacated the chair it was his pleasing duty to ask Mr. Jas. Ellis, Luton, who had been president of the Institution for two successive years—1916 and 1917—to accept an illuminated address from the members in recognition of his work. Mr. Ellis, during two critical years of the war, discharged the duties of President with marked acceptance. It was a difficult period when Mr. Ellis held office, but he had performed his work to the satisfaction of all.

MR. ELLIS, in acknowledging the gift, said that anything he had been able to do in the past for the Institution had been done whole-heartedly and quite willingly. It was a satisfaction to note that, while older members could now sit down and rest if necessary, there was an abundance of young and enthusiastic blood capable of carrying on the good work. It was extremely gratifying to some of them like himself, who had watched the progress of the Institution since its inception, to note the wonderful results that had been achieved. He felt sure, with the young and enthusiastic men who were now working for the Institution, that its future was assured.

MR. LITTLE said that a more recent President than Mr. Ellis was Mr. T. H. Firth, Sheffield. All would agree that the Institution during the seventeen years of its history never had an abler President than Mr. Firth, who discharged the duties in the year 1918. On behalf of the Institution, he had to ask Mr. Firth's acceptance of an illuminated address done up in volume form.

MR. T. H. FRITH, in acknowledging, said anything he had done for the Institution was regarded by him as a labour of love. He was sorry he could not make the announcement that the Charter had been got, but he believed it would soon be an accomplished fact. Owing to a change in the secretaryship, the subject had been somewhat neglected.

MR. LITTLE at this point invested Mr. Riddell with the chain of office, and vacated the chair.

THE PRESIDENT, who was cordially received, said he had always been keenly interested in the educative side of the Institution's work, and, of course, he was sometimes prone, as they knew, to express views that were perhaps not quite popular. When the Council approached him with an invitation to become the President, he at first declined, because he had the feeling that he was somewhat out of sympathy with the views expressed at the meetings of the Institution, particularly by the younger men. The Council persisted in their invitation, and eventually he consented, although he frankly warned them that they might hear their President giving expression to views that they did not altogether like. He supposed the real reason for his promotion was that the Council were anxious to honour the Scottish Branch. He had been associated with the Scottish Branch from its foundation, and, along with Professor Campion and others, he had tried to keep the Scottish Branch in prominence. Mr. Macfarlane, the secretary, had just informed him that the membership of the Scottish Branch was now 341. That was most gratifying news, and he wished it could be three times bigger yet. He certainly would do all he could during his tenure of office to further the work of the Institution.

Election of Officers.

THE PRESIDENT said the first duty that fell to him in his new office was to nominate Mr. Oliver Stubbs, Manchester, for the position of senior vice-president.

MR. T. H. FIRTH, Sheffield, in seconding the nomination, said that in promoting Mr. Stubbs they were electing one of their most capable members

MR. G. E. ROBERTS, Coventry, nominated Mr. H. L. Reason, Birmingham, for junior vice-president. MR. O. STUBBS, in seconding, said that Mr. Reason had been nominated by the Council to represent the Institution in regard to the research work that was being carried on in connection with non-ferrous metals. They would recognise then that the Council considered Mr. Reason to be an exceptionally valuable member, and his appointment as junior vice-president would be appreciated by many members.

The appointments of Messrs. Stubbs and Reason as senior and junior vice-presidents respectively were agreed to unanimously.

MR. W. MAYER, Dumbarton, proposed the reappointment of Mr. F. W. Finch as treasurer. MR. F. J. COOK, West Bromwich, seconded the proposition, which was unanimously agreed to.

THE PRESIDENT said it was fitting that he should put forward the proposition nominating the appointment of the general secretary of the Institution, because the President came most directly into contact with the secretary. Accordingly, he submitted the name of Mr. W. G. Hollinworth for the post. Mr. Hollinworth was new to them in Scotland, since it was only quite recently that he had taken over the post vacated by Captain Hayes. It was freely acknowledged that the latter

performed yeoman service for the Institution. He showed great ability, but the Council felt convinced that in Mr. Hollinworth they had found a successor who was equally efficient in secretarial work. Personally, he felt they had made a good choice in selecting Mr. Hollinworth, and he proposed his appointment as general secretary.

Mr. John Little, in seconding the proposition, said the impression he had already formed of Mr. Hollinworth was that he was likely to prove a valuable official. He was anxious to do what he could to further the welfare of the Institution and to make it a success. Mr. Hollinworth, it was interesting to point out, had previous secretarial experience, and that, too, in technical societies or institutions similar to their own.

The proposition was put to the meeting, and carried unanimously. Mr. Hollinworth, in acknowledging the cordiality of his reception, said his one desire was for the growth and development of the Institution, so that they would all be proud to say they were connected with it.

The trustees, Messrs. R. Buchanan, F. J. Cook and W. Mayer, were formally confirmed in the position.

Messrs. Frank Creke, Harcourt and Co. were re-elected auditors.

There were eight nominations for four vacancies on the Council, and a vote by ballot was taken. Messrs. Firth and Stubbs were appointed scrutineers, and at a later stage of the proceedings the President reported that the voting had resulted in the return of the following:—Messrs. E. H. Broughall (Coventry), A. Hayes (London), H. Jewson (East Dereham), and J. Shaw (Sheffield).

Alteration in Rules.

The President said that the Council, in the course of a recent revision of the rules, came to the conclusion that there was an urgent necessity for effecting a change in the fees of membership. That forenoon they had already seen, in a discussion that had arisen out of the financial statement, that there was a necessity, if not, indeed, an urgency, for improving the financial position of the Institution. Nearly all the large technical societies had increased their subscriptions a considerable time ago, and the Council was most desirous of making certain that the revenue derivable from subscription fees would be sufficient to meet the expenses. Accordingly he had pleasure in moving the following proposition:—

"That in view of the increased expenditure in carrying on the work of the Institution, it is resolved that the subscriptions be increased as follows:—Members from £1 1s. to £2 2s. per annum; Associate Members, from 10s. 6d. to £1 1s. per annum; Associates, from 3s. to 10s. 6d. per annum; subscribing firms, £5 5s. per annum—the new rule to come into operation January 1, 1921."

Mr. John Little, Manchester, in seconding the proposition, said that the Council, as the outcome of a lengthy consideration of the subject at two or three meetings, had come to the unanimous finding that the subscription fees must be increased. It might be thought that the proposal to increase the fee of Associates from 3s. to 10s. 6d. was proportionately large, but the position was really this, that every Associate they had cost the Institution a little money. As they well knew, the charges in respect of printing had increased to an enormous extent. In point of fact, printing cost the Institution about three times the figure it did two or three years ago. In addition, the office expenses had gone up, but as against that there had been no increase in subscription fees. Until the annual subscriptions for membership were raised, the Institution, from a financial point of view, was bound to remain in trouble. Many of the other technical societies with which some of the members happened to be connected had long since increased their subscriptions—in a few instances, in fact, the fees had been actually doubled.

Mr. G. E. Roberts, Coventry, said he rose to propose an amendment, which he felt would evoke some sympathy in this part of the country. His proposal was that the fee of the Associate Member ought not to be advanced to the extent of 10s. 6d., but should go up, say, to 7s. 6d. He felt it would be in the best interests of the Institution not to take any steps that would discourage the influx of new members from the ranks of juniors. On the question of the increasing expenditure of the Institution, he had to say that those of them who represented the Coventry Branch intended to give special attention in the present year to this important detail of administration. Coventry could lead the way in the direction of economy.

The amendment proposed by Mr. Roberts was duly seconded.

Mr. Bell (Scottish Branch) thought the Associates should not be differently treated from the ordinary members, whose rates of subscriptions were only proposed to be increased by 100 per cent.

Mr. W. Mayer, Dumbarton, said he was anxious to emphasise a point that had been made by the President and Mr. Little. The Institution was at the beginning of financial trouble if it did not adopt some such scheme as that outlined in the proposal before the meeting.

Mr. Gallon said that, in his view, Associates would be no worse off than other members of the Institution if this proposition was carried. For instance, he would undertake to say that not many works managers had had their salaries raised 100 per cent. The wages of some workers, on the other hand, had been advanced to the extent of 130 per cent., and in certain cases to as much as 175 per cent. Altogether he felt quite sure that the average Associate—the ordinary workman, forgeman or labourer—was quite as capable of paying this higher fee of 10s. 6d. as some of the managers were to pay the increase suggested in their case of one guinea.

Mr. F. J. Cook, West Bromwich, said he had been in close touch with this matter from the very beginning. The original object in fixing the fee of the Associate at three shillings was to encourage workmen to attend the meetings of the different Branches, and to take part in the discussions. Never at any time had workmen joined in with them in large numbers, and, as a matter of fact, they were latterly what he might call a decreasing quantity. According to the report, the number at this stage was 294, as compared with 301 at the corresponding date last year. As one of the first secretaries of a Branch of the Institution, he could say that the most troublesome member he found was the Associate. He referred, of course, only to his dilatory method in the matter of paying his subscription. The amount of time expended in hunting up the Associate and prevailing upon him to pay his subscription was almost twice that needed for any

other class of member embraced by the Institution. When originally fixed, the modest fee of 3s. was believed to be an attraction to this type of workman, but he thought he was right in saying that, in the main, the experiment had failed. It was a significant fact that throughout the British Isles they could only find a matter of 290 Associates. Then he did think that the type of young men whom the Institution specially desired to encourage would not be deterred from joining because the subscription fee had been increased to 10s. 6d. So far as the question of financial values was concerned, he thought—especially when they considered the financial position of the men they were aiming at—that 10s. 6d. to-day did not stand in a very bad relationship to 3s., the sum fixed when they originally agreed upon this experiment. All along, the Institution had been considerably hampered because of lack of funds, and, as a matter of fact, the Council had always been obliged to proceed very gingerly in the matter of the formation of new Branches. Indeed, the position, strictly speaking, was this, that there were a great many Branches they would like to form if they had the money at their disposal ready to launch out. The progress they might make did not end with the formation of new Branches, because there were many other things the Council would like to do if they had the necessary funds.

Mr. J. Macfarlane (secretary of the Scottish Branch) said he sympathised with the view taken by one of the speakers that a hardship might be dealt out to certain of the Associates if the membership fee in their case was raised from 3s. to 10s. 6d. For example, in the Scottish Branch they had what he might describe as a very real section of Associates, whose membership fee was restricted to 3s. There were two members of the Scottish Branch who had charge of classes for apprentices. He referred to Professor Campion and another gentleman who conducted classes attached to an ordinary evening school. The classes were specially designed for apprentices in foundry practice, and both Professor Campion and the other gentleman referred to sent these lads forward as Associates of the Scottish Branch of the Institution of British Foundrymen. He suspected that Professor Campion and the other gentlemen themselves paid the membership fee of many of these lads. Personally, he had no desire to see the membership subscription kept at a low rate, but it just occurred to him that if they increased the fee from 3s. to 10s. 6d. they might be effectively closing the door altogether against these apprentice youths remaining in the membership of the Institution. In the Scottish Branch they were not losing anything at all, even on the members listed at 3s., because they were able to run the Branch at an average cost of 2s. 9d. per member over all. Then it was a point to be noticed that these youths or boys attended the meetings with regularity.

Mr. F. J. Cook said Mr. Macfarlane had clearly alluded to members who were under 21 years of age. Speaking for himself, he should like to see a new form of membership introduced into the Institution—a student membership—and he would even agree to students being admitted at an annual membership fee of 3s. That, however, was a proposition a little outside the one presently before the meeting.

Mr. A. Fraser, Blair Foundry, Ayr, said he thought there was room here for the exercise of a spirit of compromise. Those of them who were employers or managers ought to make a point of seeing that the employees were encouraged to attend the Branch meetings of the Institution. It did, however, seem to him that the suggested increase from 3s. to 10s. 6d. was excessive. He was inclined to think that the proposal from Coventry to make the fee 7s. 6d. was a reasonable compromise. An advance to that point, taken in conjunction with the other increases recommended, would, he felt, be quite adequate

Mr. O. Stubbs, Manchester, said it was quite evident to his mind that the Institution could not be successfully carried on unless it had finance behind it. The suggestion put forward by Mr. Cook, that there should be a student form of membership, was an excellent one, and something along these lines might be attempted. But if the Institution was worth having it was surely value for 10s. 6d. from an Associate. The Associates to-day, large numbers of whom were moulders and core-makers, were making very good money, and he contended that the great majority of them were in a position to pay a membership fee of 10s. 6d.

Professor Campion said he most cordially supported the speakers who felt that the fee of the Associate should be increased to 10s. 6d. At the same time, he should like to suggest that boys who were attending technical classes should be permitted free entrance to all the open lectures under the auspices of the various Branches of the Institution of British Foundrymen on the presentation of a signed note from their teacher. If a person had not sufficient interest in the Institution to enable him to spend, say, 10s. 6d. in a membership fee, then he was doubtful if the Institution held any great interest or attraction for that individual at all.

On a division, four members supported the amendment proposed by Mr. Bell, that the fee should be increased to Associates from 3s. to 6s., while seven voted for the amendment put forward by Mr. Roberts, of Coventry, that the subscription should be advanced to 7s. 6d. Eventually, the recommendation of the Council to increase the fee to 10s. 6d. was declared carried.

The other fees as embodied in the proposition formally moved by the President and seconded by Mr. Little were also endorsed by the meeting.

Mr. T. H. Firth, Sheffield, said that, arising from the proposition just carried, he should like to remark that it did seem to him as if there were a large number of firms in the United Kingdom who would be pleased to become subscribing members of the Institution. These firms, he felt sure, would, if approached, readily pay the subscribing fee of five guineas. If the President did not mind the interjection at this point, he should very much like him to remind members of the good office performed to the Institution whenever they succeeded in getting a firm, in whom they were interested, to become subscribing members. It did appear to him that possibly a little more might be done in this direction if only members would bestir themselves. Personally, he hoped the day was not long distant when they would be in a position to pay a secretary for the whole of his time. He did feel there were very few firms in the country who would not willingly give an annual subscription of five guineas to the funds of the Institution.

The Revision of Rules.

THE PRESIDENT said that, so far as this question of the revision of rules was concerned, the position really was this, that they had grown too big for their clothes, and so they had been obliged to make a new suit for themselves. The principle they had tried to keep in view in framing the new rules was to afford Branches considerably more liberty in the matter of work, and to feel that they were not being held too strongly to the apron-strings of the parent body. For example, the position at present was that all money had, in the first instance, to be passed on to the general secretary at the head office. All the funds that local Branches had to work upon were those which they might get from the parent body by means of requisitions sent to headquarters. Those requisitions, he might remark in passing, were very carefully scrutinised. Under the new arrangement it was proposed that the Branches should, as formerly, send their moneys on to the General Council. On their part, the Council would impose a levy for headquarters' expenses, etc., based on the membership, and the balance would be returned to the local Branches to be expended by them in any scheme of development, etc., they cared to undertake. The main idea underlying the new scheme of things was that there should be a certain amount of Home Rule, so to speak. The rules as revised had been most carefully considered by the Council.

MR. F. J. COOK said he believed these rules had been before all the Branches, and that many of the Branches had forwarded suggested alterations, which had been most fully discussed. He had pleasure in moving the adoption of the rules as revised, with the exception of a possible addition to Rule 3 so as to include the suggestion introduced in the course of the discussion that day that they should have in connection with the Institution a new form of membership, namely, a student membership. As at present drafted, the rules did not permit anyone joining the Institution who was under 21 years of age. Personally, he must plead guilty to having broken the rules on many occasions, and having drawn into the fold some who were under 21 years of age. His justification for that infringement of the rules was because he thought and felt that those who had been nominated and admitted in that way were keen. Accordingly, he was now prepared to move that the revised rules be adopted *en bloc*, and that there be an addition to Rule 3 providing for student membership, with a subscription fee in such instances of 5s. annually.

MR. ROBERTS, Coventry, said he was prepared to second the proposition moved by Mr. Cook.

MR. OLIVER STUBBS supposed that all student members would be under 21 years of age.

PROFESSOR CAMPION, Glasgow, indicated that the average student coming to the Royal Technical College, Glasgow, was not less than 17 years of age. Under present conditions, he was over 21 years of age before he had completed his course.

MR. STUBBS, Manchester, remarked that the point now raised caused him to wonder how much it was going to defeat the proposal they had just agreed upon, that the annual subscription fee of an Associate Member should be 10s. 6d? If there was a distinct stipulation that the student member must be attending a technical school, he was prepared to agree, but he felt there must be that safeguard, or they would defeat the object aimed at in agreeing to raise the fee of the Associate Member to 10s. 6d.

PROFESSOR CAMPION thought the difficulty could be got over if the student applying for membership presented a countersigned nomination by a teacher certifying that he was in attendance at a regular course. The Student Member, he felt further, would have to become an Associate Member when he reached 21 years of age.

Eventually, after further discussion, it was agreed, on the proposition of Mr. T. H. Firth, Sheffield, seconded by Mr. O. Stubbs, Manchester, that the revised rules be adopted as printed.

Presidential Address.

THE PRESIDENT (Mr. Riddell) delivered the following address:—

Gentlemen,—Our institution has now reached its seventeenth annual meeting. From a membership of less than 100 when the first convention was held in Manchester, in 1904, its numbers have grown till there are now fully 1,800 on the roll. These figures indicate very gratifying progress; nevertheless, when we consider the many thousands who are engaged in the founding industries, we have to admit that it is only a small fraction of those who ought to be associated with us.

In view not only of what the Institution has done, but also of what it is striving to do for the educational welfare and the working conditions of the industry, no live worker with any interest in his craft can afford to keep outside. It rests on us, therefore, by propaganda work and all other means at our command, to further the aims and objects for which the Institution was founded, and to make our fellow foundrymen realise that its claims are of supreme importance to the industry.

One important change which has been brought about mainly through the activities of our Society is the greater respect which has been accorded to the status of the foundryman. It is not so long ago since the foundry trade was looked down upon, and its calling as one requiring mere physical strength rather than mental ability. This view, of course, arose from sheer ignorance of the requirements of the craft. It was not understood that there are few professions which call for a greater combination of scientific knowledge and artistic skill than that of the foundryman.

Someone has described cast iron as the daily bread of all other industries. The variety of purposes for which it is used, the different physical properties required, and the many complicated shapes and forms into which it has to be made, all combine to give the foundryman problems to be solved as difficult as are to be found in any of the industrial arts.

The two features of our organisation which appeal most strongly to me are its educational possibilities and the democratic nature of its membership. Its ranks are open to all engaged or interested in foundry matters. The scientist, the manager, the foreman, the moulder, and the labourer are one and all united each to do his share of contributing to the general knowledge.

Its methods are educational in the highest degree, because the practical man is encouraged to apply all his faculties of observation, and to note the results of his experience in the daily routine of his work. By tackling the never-ending prob-

lems which confront him in the foundry, he not only increases his store of knowledge, but is at the same time developing a spirit of self-reliance and independence, and is fitting himself more thoroughly for his special place in life. Such men, though they may never have attended a science school, are thoroughly skilled in their departments, because they have been observant and reasoned out the cause of things. They call themselves practical men, yet they are true scientific men who have studied in the school of experience on scientific lines.

No one who reads the reports of the papers and discussions which appear in the printed "Proceedings" can gainsay that our Institution has achieved a notable success in establishing a large amount of formulated science in an industry which but a few years ago had no science at all. Under its influence the "hit-and-miss" and empirical methods which were sufficient for our forefathers are gradually passing away. That such results have been possible is due, in large measure, to the opportunities which our meetings afford for bringing the scientist and the practical man together in tackling the problems which present themselves.

There is still a long road to travel before our journey is completed. A vast amount of research work lies before the industry, and in this the Institution must take the leading part. While at present its funds preclude it from directly carrying through such work, it can, and must, use its influence to create among foundrymen the necessity for systematic research, and, if required, to lend all its aid in organising any such schemes as may be promoted. Reference has been made in the Annual Report to the proposed Grey and Malleable Cast-Iron Association. All the preliminary steps for the establishment of that Association, which is under the Government scheme and similar to those set up in connection with other industries, have been carried out by your Council during the past year. Whilst this is so far satisfactory, I am of opinion, and considering the extensive ramifications and the wide distribution of the cast-iron industry, there still remains the need for district research laboratories to meet the requirements of the locality. Marine engines, internal-combustion engines, textile machinery, light castings, etc., all have their own special problems inviting solution. With the special laboratory, not only the metal, but the whole material and operations can be investigated.

I am pleased to say that the town with which I am connected has taken the lead in this respect. The Light Casting Founders of Falkirk have already set up such a laboratory, under the superintendence of Prof. Campion. In addition to research, educational work in foundry subjects, a branch of study which has been sadly neglected by our technical schools, has been instituted. These schemes of research are not to be regarded as substitutes, but rather as aids to similar work in the foundry. Research is open to every practical man who has an interest in finding out governing principles and the reason why certain things result. It is not necessary to go far for material on which to work. It lies under our hand every day in the workshop. Many difficulties may have to be overcome, but these to the diligent worker serve only as a challenge to do his very best. The man who is alive is ever seeking problems to solve. The school of difficulty is the best school of moral discipline for individuals, and the foundry will be found to be an excellent training ground. It is wonderful what can be accomplished when one only tries. Nobody knows what he can do till he has tried. As the rhyme says:—

"'Tain't no use to sit and whine,
When the fish ain't on your line,
Bait your hook and keep on tryin';
Keep agoin'."

Every encouragement and every inducement ought to be given to the apprentices, and particular care paid to their comfort; but I do not agree with the present idea of carrying boys to schools in perambulators and taking them away in motor-cars. The world, to my way of thinking, has not been improved by people getting things easily. I do not believe in working 47 hours a week and getting off every other forenoon and afternoon for special trips. Mere book-learning is not an education; it is merely reinforced ignorance. The present methods of education are developing ergophobia, and we hear more talk about striking than about working. We do not grudge the men leisure if they make proper use of it, but much of it is devoted to self-amusements, while games have nowadays developed into a disease. On the educational question I have certain strong views. I really do think it does the boys harm to get education during working hours. In my opinion, they ought to sacrifice a little of their time in gathering experience and knowledge. I would like to see the works used for teaching a boy his trade, and for no other purpose. For Heaven's sake, do not stultify the boy's chance of success in life by making him a professor if the intention in the first instance is that he should be a moulder.

Mr. R. Buchanan, F.R.S.A., Birmingham, in the course of a few felicitous remarks, proposed a vote of thanks to the President for his address. There was, perhaps, just a tinge of pessimism pervading the address of the President. He was obviously a gentleman of ideals, and it was refreshing to feel that Mr. Riddell, who was one of the finest of gentlemen, could manifest the deep and profound interest he did in the welfare of the Institution. In so doing it was evident he was animated with the feeling that he was working not only for himself and for his fellows, but for his country. Notwithstanding the views that the President had introduced on the question of education, he (the speaker) was inclined to look a little towards the optimistic side of things.

The President, in a word, acknowledged the vote of thanks, which was marked by much cordiality.

Fraternal Greetings.

Mr. Oliver Stubbs, Manchester, said he thought it would be a graceful thing if, at this annual meeting, they were to pass a resolution of fraternal greetings to the American Foundrymen's Association. Frankly, he was a great believer in the cordial and harmonious interchange of views and opinions. Already they had been splendidly received by their friends on the other side of the Atlantic, and he thought the bond of good comradeship and sympathy would be further cemented by an exchange of greetings.

The proposition moved by Mr. Stubbs was

seconded and agreed to unanimously. It was remitted to the secretary and the President to co-operate together in framing an appropriate greeting.

The Retiring President Thanked.

MR. MILES said he thought it would be fitting if, at the present stage, they passed a vote of thanks to the retiring President and his officers for their services during the past year.

The motion was formally seconded by MR. LANDALE, and agreed to unanimously.

MR. JOHN LITTLE, Manchester, in acknowledging the vote of thanks, said it had not altogether been a bed of roses during his term of office. He felt, however, that in the year upon which they had entered, and in subsequent years, they would get the benefit of the work done during the past twelve months. There was no question of this, that the change in the secretaryship made things somewhat difficult. Circumstances had been rather against them during the past year, but he did not know there was anything to regret after all. For one thing, he had a splendid lot of officers co-operating with him in his work. All through he was most loyally supported, and he felt not a little confident that what had been done during the past year would have beneficial results in the future.

The Civic Reception.

In the course of Wednesday afternoon the delegates were received by the Lord Provost and Magistrates on behalf of Glasgow Corporation. LORD PROVOST STEWART, in an interesting address of welcome, said the Glasgow Corporation, as well as the general ratepayers of the city, recognised the importance of the Institution, representing, as it did, those who were responsible for the conduct of one of the oldest industries. In more modern times, although much decorative work was done, and our domestic work depended much upon the foundry, the chief development of the industry had been seen in the great progress made in the mechanical world.

MR. M. RIDDELL, President of the Institution, in acknowledging the welcome to the delegates, said there was no city in the country more indebted to the iron trade than Glasgow. The Institution was seeking the educational improvement and social welfare of everyone connected with the industry. They were trying to get the men to take a real interest in their work instead of finding it a drudgery, to be performed with an eye on the clock.

The civic reception was numerously attended by the delegates and their lady friends, and the function passed off with considerable *éclat*.

Thursday's Proceedings.

MR. M. RIDDELL, President, again occupied the chair on Thursday morning, when the proceedings were resumed. The attendance of delegates was quite representative.

America and Great Britain.

THE PRESIDENT said it would be recalled that on the previous day it had been agreed to send fraternal greetings to the American Foundrymen's Association. He was glad to say that a representative of that Association was again at their meeting that day. He referred to Mr. H. Cole Estep, the European manager, resident in London, of the Penton Publishing Company. He had been introduced to Mr. Estep on the previous day, and he found him an eminently respectable gentleman—the solution of that probably being that their friend, besides being a member of the American Foundrymen's Association, was also associated by membership with the Institution of British Foundrymen.

MR. H. C. ESTEP, who was invited to speak, said it had been exceedingly gratifying to him as a member of the American Foundrymen's Association, to hear the fraternal resolution passed on the previous day. He was quite confident that the resolution would be well received when its terms were communicated to the twenty-third annual meeting of the American Foundrymen's Association, which fell to be held at Columbia, Ohio, on October 4, 1920. He understood some of those in attendance at the present meeting contemplated making the trip across in order to attend the meeting, and he felt quite sure that every effort would be made to make their stay on the other side thoroughly enjoyable. He had to confess, however, that the American facilities for hospitality were far inferior to those of this delightful country at the present time—and particularly this very special part of the British Isles. Frankly, he did feel that great good would be accomplished through co-operation between the American Foundrymen's Association and the Institution of British Foundrymen, and he was inclined to think that an exchange of opinion as embodied in the technical papers submitted to each society would be most beneficial and useful. It did seem to him that the foundry industry had made greater progress during the past 25 years than in the preceding years of its history, simply for the reason that foundrymen were now more disposed to come into the open and discuss their common problems with each other. As the saying ran over in the States, they had abandoned the policy of going into a hole and pulling the hole after them. It would be a real good thing if the suggestion hinted at on the previous day for an interchange of papers between the Associations in America and Great Britain could be carried through. Then, if the transportation arrangements would settle down somewhat, greater numbers might be induced to attend the respective meetings in America and Great Britain. Indeed, he hoped the day would come when at least twice in every decade there would be two joint meetings of the American Foundrymen's Association and the Institution of British Foundrymen—one meeting on each side of the water.

Concluding Votes of Thanks.

MR. G. E. ROBERTS, Coventry, said it was his great privilege to address to the Governors of the Royal Technical College, Glasgow, the most grateful thanks of the members of the Institution for the use they had afforded of their premises for the business meetings connected with the Conference. He was quite sure their meetings could not have been held under more congenial circumstances. Then he believed it would be most acceptable to the delegates present if he proposed a vote of thanks to the Committee of the Scottish Branch for the satisfactory arrangements made to suit the convenience of all attending the annual meeting. All the delegates, he felt sure, would carry away with them happy recollections of the time they had spent on this occasion in the city of Glasgow. He had pleasure in moving a vote of

thanks to the Governors of the Royal Technical College, Glasgow, to the Scottish Branch of the Institution, for the magnificent work they had done; to Mr. J. Macfarlane, the Scottish Branch secretary; and, in fact, to everyone who had in any way contributed to the general happiness of the meetings.

Mr. F. J. Cook, in seconding the motion, said Mr. Roberts had most happily expressed the feelings of all the delegates.

The Chairman, in acknowledging the vote of thanks on behalf of the Scottish Branch, said that the typical Scotsman was always keen to make foreigners from across the Border most comfortable. He supposed the chief reason for that lay in the fact that so many strange things were said and written of Scotsmen. The Scottish Branch, however, would feel well repaid for anything that had been done if they had the satisfaction of knowing that all the visitors had thoroughly enjoyed themselves.

The business part of the proceedings was at this point brought to a close.

Note.—*The discussions of papers found elsewhere in this issue will appear next month.*

COMMERCIAL VEHICLE EXHIBITION. — In connection with the forthcoming Commercial Vehicle Exhibition, to be held at Olympia from October 15 to 23, we understand that the applications already received for space for commercial motor vehicles of all descriptions, including electric and steam-driven vehicles, are sufficient to cover the whole space available. Accessories, components, and tyres, other than those primarily intended for use on private motor cars, will be shown, including pneumatic tyres for commercial vehicle use. This is the first time such tyres have been admitted to these exhibitions, and marks the definite introduction of the pneumatic tyre for commercial vehicle use generally.

THE MACHINE TOOL AND ENGINEERING EXHIBITION. — One of the main objects of the Machine Tool Trades Association in promoting their exhibition, which opened at Olympia on Saturday, is to encourage the extension of the overseas trade in machine tools. There are only three countries in the world in which machine tools are manufactured on a large scale, viz., the United Kingdom, United States, and Germany. During the war the machine tool maker was so occupied in satisfying the requirements of munition makers that the overseas markets were neglected, and, in fact, the Ministry of Munitions would only permit the export of such machine tools as would be likely to help in the production of munitions for one Allied country or another. In order to bring as many foreign engineers to London as possible, a widespread scheme of publicity has been organised, and seems likely to prove highly successful. The exhibition has been advertised in practically every European paper of importance, and every advertisement contains an invitation to the engineers of the country in which the particular paper circulates to apply for a free season ticket of admission. In addition to this, 12,000 invitations have been issued to engineers all over the world, and already communications have been received from practically every country in the world announcing their intention of visiting the exhibition. The managing director of a very important Continental engineering firm has written to say that he is building an enormous new factory, and he had intended purchasing the machine tool equipment in America, but, in view of the Machine Tool Exhibition, he has postponed his purchase until he can have the opportunity of seeing Britain's best productions at Olympia.

Moulding Cylinders and Foundry Costs.

The experience of the Buda Company, Harvey, Ill., in moulding cylinders with dry sand was discussed by Mr. Jesse D. Wiseman, of that company, at a meeting of the Chicago Foundrymen's Club at the City Club, Chicago, on May 8. Through the use of the method he described the output of cylinders was quadrupled. In the discussion which followed his talk, Mr. W. H. Goldstine, foundry manager, Nash Motors Company, Kenosha, Wis., stated that the character of the cylinder to be cast, the layout of the foundry, the training of the moulders, and other factors determined whether the green sand or dry sand method was the better for the job at hand. He cited the varying practice of automobile manufacturers. He was inclined to favour dry-sand castings on the grounds that they proved more accurate to standard dimensions, but doubted whether costs could be kept down sufficiently to make their use profitable. In the case of one class of work, he admitted that it might be done, but in another application it would fail. Some companies, he stated, paid great attention to accuracy, because of its relation to costs. The American Radiator Company frequently replaces its patterns as soon as it is found that castings exceed the standard weight. This is done to save the iron, which represents a considerable investment when production over an extended period is considered.

The Ferris wheel utilised by that company to transport the mould from moulder to ladle hand was mentioned as another example of the radiator company's attention to costs.

Mr. F. C. Everitt, of Miller, Franklin, Bassett & Company, New York, addressed the club on his experiences in connection with foundry costs. He emphasised the importance of a good cost accounting system as the only method of getting intelligent information on costs. Cost accounting, however, is an engineering and not an accounting problem. No system superimposed by the office on a foundry will work. The scheme must be built up in the various departments with proper attention to their peculiarities, as different conditions require different treatment if worth-while information as to costs is desired. He cited concrete examples of the successful application of time studies and new methods of handling labour in a given plant. Cutting piece work rates, he stated, killed the ambition in workmen and meant sure defeat for any plan for increased output. Sometimes granting a bonus for greater group production works better than offering a premium to the individual worker.

SMALL HALF-WATT LAMPS.—When the gas-filled or half-watt type of lamp was put on the market half a dozen years ago it could not be manufactured except in comparatively large sizes (500 watts and upwards for 100- and 200-volt circuits), and therefore little use could be made of it for house lighting and other purposes, where large units of illumination are not required. The development of 60-watt lamps for 100-volt circuits and of 100-watt lamps for 200-volt circuits was a considerable advance, but there still remained many conditions for which these sizes were unsuitable. Now a further advance has been made, and the production of 100-130-volt lamps of 40 watts and of 200-260-volt lamps of 60 watts should materially add to the sphere of usefulness of the type. The diameter of the former size is approximately 2⅜ in., and the length 4¾ in., while the same dimensions for the latter are 2¾ in. and 5¾ in. Both lamps have ring filaments, and can be used in any position, and standard bayonet caps are the normal fitting.

Science in the Workshop.*

By W. H. Cathcart.

During the last few years this most important subject has been very considerably written about and discussed. With most of the opinions expressed in connection with several recent Papers I am in complete agreement, but to others I am in decided opposition. For example, while I fully appreciate the fact that much is being done to bring more scientific knowledge into the workshop, yet I feel quite sure that until it be fully realised that the craftsman is a factor of greater importance than some people appear to think him, industry cannot possibly secure the fullest advantages that may be had from the valuable research which is being continually carried on by our distinguished scientists.

That this fact has not been recognised by certain individuals is to me all the more inconceivable since these same individuals have stated that the practical man has not only hampered but has also thwarted them in their efforts to introduce scientific methods into the workshop. I am quite prepared to extend my sympathy, for the very good reason that I know only too well that in a very large measure the statement is true, but at the same time I maintain and hope to be able to show that those who make this complaint are in many cases just as much to blame for this state of affairs as is the practical man. It ought to be quite obvious that the right thing to do is to make every effort to eliminate the prejudice and ignorance which is the real cause of the trouble, but, instead of doing so, it has actually been suggested that the practical man be exterminated. Drastic treatment, forsooth, and methinks not quite in keeping with the usual practice of the British medical profession in dealing with any poor patient, however bad he may be. No, there is to be no extermination of the practical man. If it be true that his influence is of sufficient importance as to retard progress in the workshop, it is equally true that the same all-powerful influence may, by proper enlightenment and tactful guidance, become one of the chief factors in attaining the end that we all so much desire and endeavour to bring about.

During the years which have elapsed since first I discovered the value of science applied to my own practical work, I have taken advantage of every opportunity of urging my own fellow craftsmen and others to engage in the study of the scientific principles which govern their work, and also of emphasising the importance of establishing a closer relationship between scientists and practical men. I have very strong feelings regarding such a remark as I have hinted at, since it is bound to increase the difficulty of my task, and that of others who are like minded. It is much to be deplored, since it comes from the teaching profession, the very profession from which we have derived so much benefit, and on which we have been depending for assistance in our efforts to improve the knowledge of the men in the workshops.

In attempting to introduce science into the workshop, I fully appreciate the difficulty experienced by anyone who has not been brought up amongst the workmen. It is not altogether his fault that, for many reasons, he is considerably handicapped; but, in many cases, his want of success is due to the fact that the workman is approached in such a manner as to give the impression that he is ever so much inferior. Naturally, just as is to be expected, whatever may have been the extent of the prevailing prejudice, it is increased thereby a thousandfold.

Having been trained in the workshop, and being, in common with my fellow craftsmen, possessed of all the inner knowledge, knowledge not known and consequently not appreciated by an outsider, I have in my own efforts met with a large measure of success. I am satisfied, therefore, that if the problem be dealt with in the right spirit, much good may be accomplished. By coming more in contact with each other, and by exercising a spirit of mutual respect, much might be done towards breaking down, on the part of the practical man, the prejudice which exists against anything of a scientific nature, and, on the other hand, the scientist might well discover that, while the craftsman makes daily use of a great deal which is not systematised knowledge, he nevertheless continuously carries out a large proportion of his work in strict conformity with the scientific principles which govern it.

In order to overcome the prevailing prejudice of practical men against science, it is necessary to get them to realise the fact that science and practice are not opposed to each other. Indeed, they are inseparable. Separation is just as inconceivable as in the case of the mind and the body of a human being. In either case, if separation does take place, the consequences are equally disastrous. Furthermore, I maintain that the performance of any operation pertaining to any art or craft cannot possibly be truly practical without science. Science consists in systematic observation of facts and intelligent deduction therefrom, while art is the application of these facts. These facts are certain fixed laws or principles which govern every practical operation. Consequently, art in the true sense—except it be due to mere coincidence—cannot come into being without some knowledge of these laws. In my opinion, therefore, science may be quite justifiably regarded simply as knowledge.

I assert, therefore, that every practical man who knows what he is doing is truly a scientist. When he does not know what he is doing, he ceases even to be a practical man, and I contend that, while he persists in carrying out his work in accordance with haphazard rule of thumb methods, he is not a craftsman in the grandest sense. In attempting to induce craftsmen to abandon all these indefinite methods, it is exceedingly difficult to get them to realise that the so-called scientific method is no new institution. Every successful practical operation is performed scientifically, even although the craftsman may be ignorant of the fact. Moreover, every unsuccessful operation is governed by scientific laws. If a workman, for example, burns a piece of steel in the forge furnace, or overheats his metal in the melting pot, it is bad practice, but it is in accordance with a scientific law with which the workman ought to be conversant in order that he may be better able to guard against the recurrence of the evil.

If the craftsman would take the trouble to reconsider his prejudicial opinion, which has un-

* Paper read before the Institution of British Foundrymen, Annual Conference, Glasgow, 1920.

doubtedly been formed without due examination, he would find that all that is necessary is simply a greater and a deeper knowledge of the principles which govern his particular craft. It is the duty of every intelligent craftsman in the smithy, the forge, and the foundry to realise that he belongs to a craft than which no other can be more truly scientific, and that he ought to make every effort to increase his knowledge. Furthermore, it is equally the duty of every science teacher to teach scientific principles, not only to the scientist, but also to the practical craftsman.

From certain opinions expressed recently, it would appear that the chief concern of many scientists is the better training of the laboratory staff. With this I am in whole-hearted agreement, but how can we expect to get the very best possible results if we do not take the same steps to train the practical man? What is the good of carrying out some important research in the laboratory if the men in the workshop who are to apply it are not trained to do so correctly? Of course, it has been suggested that this is one of the very good reasons for training the laboratory staff, so that they may be fitted to go out into the workshop to control the practical operations. Evidently there is on the part of the practical man not only a lack of knowledge, but also a lack of the necessary intelligence to permit of his being trained.

It would appear as if there were an impression abroad amongst some people that a craftsman is only a manual worker, a kind of superior labourer whose chief qualification need only be that of doing smartly just that which he is told without any initiative on his part.

If it were not that the expression of such opinions is calculated to do much harm in hindering the co-operation of science and industry, one would feel disposed to pass over without any comment the remark—already referred to—to the effect that the practical man should be exterminated. Of course, such an attempt might well be successful if all those who are to supersede the practical man were so clever as to justify the further remark that "he would guarantee that in three months' time any scientist would learn as much as a practical man had learned in his lifetime, and in that of his father's and grandfather's, from whom most of his experience was derived." I wonder just why he stopped at the poor despised old grandfather. Why not have gone right back to Aaron when he cast the golden calf, or to Tubal-Cain when he forged the first plough-share?

I submit that the standpoint from which we view anything very considerably alters the matter. Some of us have before now had the salutary experience of discovering that it does make a difference when we get down on our knees in the foundry, or when we step from the front to the back of the anvil in the smithy.

I am reminded of the smith's striker who, from his long association with the smith and his observation of the ease with which he carried out his work, came to the conclusion that it was quite a simple matter, and forthwith left the shop and applied at another for a situation as a blacksmith. He was duly started, and given a piece of work to forge. Some little time after the foreman, in passing him, stopped with a puzzled look on his face. Later on the foreman came back, and, after watching him for some time, walked up to him and said: "I thought you were a smith." Reaching for his coat, our pseudo smith replied: "Yes, so did I, yesterday."

It may be somewhat superfluous on my part to emphasise the fact that the pioneers of industry, the practical craftsmen of the past, with all their lack of the scientific knowledge which is available to-day, have left on record for all time many evidences of the fact that they were possessed of intelligence and genius of the very highest order. I maintain that the potentiality of the craftsman of the present day is greater than that of his forefather, because of the definite and more reliable knowledge which has been secured through the brilliant research of our distinguished scientists.

Not as a matter of opinion, but as a matter of actual knowledge, I assert that, in the course of pure scientific research, scientists have accumulated a vast amount of valuable knowledge which is not fully taken advantage of. One reason for this is the inexperience of the scientist concerning workshop practice. Another reason is that practical men are unaware that such knowledge exists. The obvious solution is that each should realise he is the complement of the other, that each is of equal importance, and that by working in co-operation and harmony greater benefits to industry and mankind may be reaped from the labours of all.

Now, the practical man is not entirely to blame for his ignorance. Not many years ago scientists knew no more than he did, and in many respects much less. Scientists, by reason of their having the time and the facilities not afforded to the practical man, have been able to find out more and more about the laws and properties of materials, but the man in the smithy, the forge, and the foundry, for various reasons not altogether to be blamed on anyone, has not been kept in line with the increase of knowledge.

For example, long before scientists discovered the various critical points in steel, tool smiths, who are as a rule very careful and observant workmen, had been able very successfully to heat to just above what is now known as the Acl point. How many toolsmiths know that not only have scientists also discovered the Acm point, but that it is a temperature of great importance? A friend of mine, despite the fact that he had been heating pyrometrically to above the Acl point, had failed repeatedly to produce without fracture a certain important tool. On examining the steel, I found evidence of gross initial overheating. By heating to above the Acm point and quenching in oil, and then re-heating and treating as in the case of all the previous failures, success was secured.

Much valuable research has been carried out on iron, steel, and other metals, but it is much to be regretted that few of the rank and file in the smithy, the forge, and the foundry are conversant with what has been done.

I have been deeply impressed by the significant fact that many of the investigations carried out in connection with metallurgy, many of the papers read and lectures delivered, have all been done without sufficient effort being made to induce the very craftsmen who could best utilise the valuable knowledge obtained in this way to take an interest in these matters. In the interests of industry, it is absolutely necessary that the craftsman in the smithy, the forge, and the foundry should be conversant as fully as possible with the progress of investigations pertaining to his

craft in order that there may be secured the realisation of the object in view, for there is always present in connection with his work the possibility of more or less nullifying all the initial work of the scientist and others.

Let me give you an example of this kind which came under my notice during the war. This I have already given elsewhere, but I think I may be permitted to repeat it here, since it serves to illustrate several points which I am endeavouring to emphasise in the present paper. A foreman smith called on me soliciting my assistance in connection with forgings which were held up because of failure to pass the mechanical test. At the time of the first failure permission had been given to heat-treat the material. This was carried out in all sorts of ways, to be followed each time by a result no nearer the requirements than the first. The inevitable conclusion was arrived at that the steel must be bad. In accordance with this finding, arrangements were made for another firm to supply new steel. Be it noted that all this took time, and at a period of the war when every moment was precious.

The first test from the new forgings failed. Heat treatment was again resorted to, but evidently this steel was no better than the first. My friend was utterly perplexed; his manager was little better. The remainder of the mechanism was all assembled, was lying idle, and had been so for no less a period than three months waiting on these important forgings. Think of it! Three months lost during a critical period of the war. In less than three days after our interview the forgings were correctly treated, the tests were passed satisfactorily, and the nation was in possession of material in the best possible condition. Not only so, but by subjecting the first "bad" steel to exactly similar treatment, I obtained excellent results fully complying with the specification.

Oh, the pity of it! To find after all the heart-breaking worry and serious delay that the first material was perfectly good and thoroughly reliable. There need have been no delay; there need have been no stoppage of war supplies so far as these units involved were concerned, but for what? Was the man who made the steel to blame? No! Was it the engineer who erected the engine, or rather, who was waiting to erect that which he had not yet received? Most certainly not! It was the man who made the forgings and who did not know how to complete his own work: not the work of the scientist, nor of the steel maker, nor of the engineer, but his very own. Yet there are those who do not hesitate to look on the work of the smith and the forger as being of little importance. They are not, however, entirely to blame for so thinking, since the smith and the forger fail to realise their own responsibility and the far-reaching effects of their own work.

This is a typical case. Many such have come under my notice. Such cases demonstrate the unconscious ignorance of the practical man. For the man who is ignorant, and who knows he is, there is hope; but it may be little short of tragical when he is not aware of the existence of that which may help him out of many a serious difficulty.

Not only is the usual subterfuge of blaming the steel most unfair, unless when it is really known to be the case, but it is frequently a very serious hindrance to all real progress, for, after making the assertion, there the matter invariably ends, and consequently there also ends all hope or possibility of learning the true cause of failure, which for obvious reasons is very desirable.

The foregoing example serves to prove that the scientist does add very considerably to the knowledge which is essential in the workshop; that lack of such knowledge on the part of the practical man does lead to serious delay and disaster; that it is the practical craftsman who must become possessed of this knowledge; that any average intelligent craftsman is quite capable of applying the necessary scientific principles; and that the science teacher ought to fully appreciate and conscientiously deal with these important facts.

In a recent paper on this subject, Mr. Barclay, of Sheffield, says: "I am quite sure that much valuable knowledge obtained often accidentally by workmen is lost to the world because it has not been observed and recorded by trained minds." * This is undoubtedly true, but I think I am right in concluding that Mr. Barclay is thinking of the mind of the scientist, and not of that of the craftsman. Now, there are opportunities for making discoveries in the many small workshops scattered all over the country. These workshops are not in a position to maintain a laboratory, but even in the large workshops it is quite impossible for several reasons for the scientists to observe many of the interesting little problems which might well lead to something of great importance.

Train the mind of the craftsman, therefore, and if it be really a fact (which I do not for a single moment admit) that he has been endowed with a lower order of intelligence, then that is all the greater reason for his being trained to the very limit of his capacity.

Several years ago, in the course of a lecture, Dr. Rosenhain described a discovery which he had made while carrying out certain experiments in connection with slipbands. On heating a piece of iron to a temperature of about 1,200 degrees Centigrade at the central portion, with the temperature gradually diminishing towards the two ends, and then, while not subjecting it to tension, he found that, instead of breaking at the hottest portion—where one should expect—it broke at the part which was at a temperature of about 700 degrees Centigrade. Now, this was discovered about ten years ago. Thirty years ago, while working as an apprentice in a humble country smithy, I observed the same phenomenon, and since that time have observed it repeatedly, as I am sure so have many other craftsmen. The outstanding difference between Dr. Rosenhain's discovery and mine was that he was in possession of a considerable amount of the higher scientific knowledge—if you will allow me to make the distinction, since I maintain that every craftsman is a scientist—whereas, at the time and for a number of years thereafter, I had none.

My discovery came about in this way. On heating the end of a piece of iron for the purpose of upsetting, preparatory to welding, it invariably bends and requires to be repeatedly straightened. The end of such a bar is essentially heated to a differential temperature. It frequently happened that these bars broke while being straightened, and on every occasion failure took place at the part which was at about an ordinary red heat.

The same thing often happens while bending a rectangular bar to form a corner. It does not break at the central portion, even though it be

*The Journal of the Institute of Metals, No. 2, 1918. Vol. XX.

heated almost to the welding temperature, but at the part which is just red hot. It was always profitable to me to know this, and by studying closely the conditions under which it took place it was possible to guard against the danger, even although I did not know the cause. It was with exceeding great delight, therefore, that I read Dr. Rosenhain's account of his experiment, and especially his explanation.*

I use this instance to pay a well-merited tribute to scientists for the valuable assistance that they can, and do, render to the workshop, and I allow myself to be placed second to none in my feelings of indebtedness. I use it for another purpose, to bring home to all of us the important fact that, since no one has a better opportunity than the craftsman for the observation of the innumerable instances of this kind, it is imperative that steps be taken to increase his scientific knowledge if we are really in earnest in our expressed desire to secure the fruits of science.

There has been a great deal of talk about scientific control in the workshop. With this I most heartily agree, but with some of the suggestions regarding the manner of the control I do not agree. It has been suggested that members of the laboratory staff should be trained to become the future captains of industry. If they receive an adequate training in the particular craft, and have the other necessary qualifications, I have no objections whatever to their entering the field, but why train them to enter a province which legitimately belongs to someone else, especially when there is so much scope for their particular training and abilities in a direction which I am sure would be far more beneficial to science and industry?

I maintain that, by adopting some system for the scientific training of young craftsmen, it should be possible to secure workmen, foremen and managers that could not be equalled. I contend that the works manager should not only be strongly in sympathy with scientific methods, but that he should be in possession of a considerable amount of scientific attainments. His departmental managers and foremen should all be men who have actually worked at their craft, and who have received the necessary scientific training pertaining thereto.

It is true, of course, that we cannot obtain these ideal conditions all in a moment, but I suggest that in the future as much care be exercised in selecting lads for any craft as for the laboratory. While they are being taught how to manipulate their tools in the most expert manner, they should at one and the same time be taught the scientific laws which govern everything which they do. These lads should be examined periodically in knowledge and ability, and be graded accordingly. As the result of these examinations, the bulk of them would remain in the workshop as craftsmen, those of the lower grade doing the less important work, and those of the higher grade carrying out the work requiring greater knowledge and skill. Certain lads who gave evidence of exceptional aptitude and ability might well be transferred to the laboratory to undergo special training in keeping with workshop practice. As time went on it might be found desirable to retain the services of some of them in the works laboratory, while the others would return to the workshops for the purpose of controlling the work, and also providing an excellent field from which to select the managers and foremen of the future.

I feel sure that some of the men from the workshop, trained in the way indicated, could be of great service in connection with the excellent scheme for the fruitful collaboration of science and industry outlined by Dr. Rosenhain in a very interesting paper on this subject.* I was very much disappointed, however, to find that Dr. Rosenhain does not seem to have a place in his scheme for the craftsman, despite his remark to the effect that a really capable scientific investigator, who is born, not made, may even be found in the workshop.

It must not be forgotten that there is a very large number of small works throughout the country where there is no laboratory. There are, however, excellent technical schools and colleges where the intelligent craftsman can receive a knowledge of the scientific principles which govern his craft. I know that many of the craftsmen of the present day speak rather lightly of professors and other science teachers, but, as I have endeavoured to prove elsewhere, even in cases where the science teacher had no knowledge whatever of the practical application of the principle which he was teaching, that did not in the least alter the fact that the craftsman was able to apply it profitably in the workshop.†

It is not a question of the laboratory controlling the workshop; it is a question of science controlling the workshop, which may be quite a different matter. No one can deny that, if it were possible—all other qualifications being present—to have a combination of the knowledge of the scientist and the craftsman, we should have the ideal controller of the workshop. While it may not be possible to attain such an ideal, something approaching it might well be secured.

To be an ideal manager or other controller of the workshop, it is not necessary on the part of the craftsman to have the profound knowledge of the scientist, but it is necessary, on the part of the scientist, to have the profound knowledge of the craftsman. Whether, therefore, it is easier to give the craftsman just the amount of scientific training which is necessary, or to give the scientist the wide and varied practical experience necessary, I leave to the judgment of all practical men who have studied and appreciated the value of the scientific side of their business, and I maintain that they are the only persons fitted to judge.

I confess that I am utterly at a loss to understand why we should have the workshop controlled by members of the laboratory staff. I do, however, know why it is thought to be necessary. Practical men, managers and workmen alike, are slow to realise the value of science. Naturally, many scientists regard this as a sign of inability—unfortunately, this is often only too true—and therefore think and act accordingly.

I have endeavoured to show, and I have done so without fear of contradiction from either scientist or craftsman, that science is essentially a fundamental part of practice. That being so, why not teach the craftsman the whole of his business?

The right way to bring about the scientific control of the workshop is to secure, first of all, the kind of managers, foremen and workmen whom I have indicated. We already have the right kind

* Proceedings of the Institution of Mechanical Engineers, 1911.

* The Journal of the Institute of Metals, No. 1, 1919. Vol. XXI.
† "The Value of Science in the Smithy and Forge."

of research workers and others in our colleges, schools, works laboratories, and elsewhere. By instituting a system of co-operation between the laboratory staff and the managerial staff, each exercising a feeling of mutual respect, realising that each is of equal importance and is truly the complement of the other, then we may hope to be making progress towards the true collaboration of science and industry.

That there is great and pressing need for the sincere co-operation of scientists and practical men need hardly be emphasised if we are to retain the foremost position as an industrial nation. Other nations are doing more than we are in this direction. Not that our scientists are behind in any respect, but that our practical men do not fully realise that we have scientists who are second to none, that they can render most valuable assistance, and that it is imperative that full advantage be taken of it.

In conclusion, let me say that, since engaging in the study of science applied to practice, it has proved not only most beneficial, but has added very considerably to the interest and pleasure not otherwise to be had in practical work.

It was one of the happiest moments of my life when I first realised many years ago, through reading a paper by Dr. Stead, that there was such an interesting and fascinating side to practical work. Since that time I have been deeply indebted to scientists, to none more than to Dr. Stead, who has been to me a continual source of kindly encouragement and inspiration.

Measurement of Casting Temperatures in the Brass Foundry.*

By John Arnott.

Of the various factors which influence the quality of castings, temperature is undoubtedly one of the most important. It would appear at first sight that non-ferrous metals are more affected by differences in casting temperatures then cast iron. It is probable that the difference between cast iron and brass in this respect is more apparent than real. The various types of furnaces in use for melting non-ferrous metals should, if they are to be reasonably rapid and economical, be capable of heating the metal considerably above the desired temperature, whereas in the cupola the iron receives very little heat after it has been melted. Hence, I think, the possible temperature range of cast iron melted in a cupola is smaller than that of non-ferrous metals melted in coke and gas furnaces. Many of the modern furnaces, such as coke and oil tilters, are capable of bringing the metal to pouring temperature in less than an hour, and if it remain, say, another 20 minutes subjected to full blast the metal will be much too hot.

The measurement of temperatures of molten metals is a very difficult problem. It does not seem to have received the same attention as the measurement of temperatures of annealing furnaces. In such work as annealing, pyrometry has reached a high standard. Even small engineering shops have pyrometers installed in their furnaces, while the installations in some of the motor car works are on a most elaborate scale. In the foundry the position is very different. Comparatively few foundries have made any attempt whatever to measure temperatures, while the number where such readings are regularly taken is very small indeed.

The instruments employed are:—

(1) *Thermo-Couples.*—The most commonly used couples have platinum as one element and an alloy of platinum and iridium or platinum and rhodium as the other. Owing to the high cost of platinum the wires are small in diameter and also short. The general arrangement of such a pyrometer is a steel tube 2 ft. 3 in. long and 1 in. diameter which serves as a handle. At one end this tube is screwed into the junction box in which the platinum wires are connected to the copper leads. At the other end the steel tube is fitted to a coupling piece. A graphite sheath 13 in. long, 1 in. bore and ½ in. thick in walls, closed at one end, is screwed on to this coupling piece. Since graphite is permeable to gases it is necessary to encase the platinum wires in a silica tube closed at the lower end. The platinum wires are insulated throughout their length by short pieces of silica or porcelain tube. The whole arrangement is expensive, cumbersome, and easily broken. The most serious objection, however, is the time lag. The thick graphite sheath and the inner silica tube both serve as all too efficient heat insulators, and readings are nearly always low. On this account I am convinced that much of the early data published on the effect of casting temperatures is unreliable. For example, tests on Admiralty gunmetal at temperatures below 1,000 deg. C. are quoted. Reference to the thermal diagram of the copper-tin alloys shows that the larger part of the alloy is solid below 1,000 deg. C. In my experience castings poured at even 1,030 deg. C. are nearly always unsound.

A modification of this instrument is a nichrome sheath in place of graphite. The instrument is thereby rendered more robust, but, while the time lag is certainly less, it is still too great for ordinary use, and in addition the apparatus is heavy. Protection tubes of carborundum and similar materials are now available. These are fairly strong, and have a low coefficient of expansion and a high heat conductivity. It is not permissible to have the platinum wires in direct contact with the carborundum tube, hence an inner tube of porcelain or pure silica is necessary.

Base-metal couples are now made by several firms. In some of these an outer steel tube acts as one element while the other element is a nickel or a nickel-copper alloy wire insulated by short pieces of porcelain tube. This construction is cheap, strong, and allows of easy repairs, because when the hot junction is burned out it is only necessary to cut the tube and make a new weld. In some of the base-metal couples the two elements are copper or nickel alloys, and hence require to be insulated both from each other and from the steel tube. One advantage of the base metal couple is that for a given temperature the E.M.F. is much greater than that given by a platinum couple. This allows a less delicate galvanometer to be employed, which is no small matter under foundry conditions. Base-metal couples are quite satisfactory for taking temperatures of molten aluminium. For this purpose I have found that in order to get the best life from a couple the aluminium should never be allowed to come into contact with a clean surface of the steel tube. If the end of the couple which is immersed is

* Paper read before the Institution of British Foundrymen, Annual Conference, Glasgow, 1920.

previously painted with graphite or clay wash it will be found to last much longer; in fact, I have found the best life to be obtained from thermo-couples which had previously been used for some time in annealing furnaces and had thereby become covered with oxide.

(2) *Resistance Pyrometers.*—These depend on the alteration of the resistance of a spiral of platinum wire at high temperatures. Great accuracy is possible by this method, and in addition by checking the resistance of the wire when cold it is easy to detect any deterioration in the platinum. For application to molten metals, sheaths are necessary as for the thermo-couple, and a similar time lag is unavoidable.

(3) *Radiation Pyrometers.*—The radiation pyrometer has the advantage over the thermo-couple that there is no contact between the molten metal and the instrument. The principle of the radiation pyrometer is, briefly, that the heat radiated from a hot body is, by means of a concave mirror, brought to focus upon a point which is the hot junction of a platinum thermo-couple. The thermo-couple is connected to a galvanometer in the ordinary way. The difficulty I have experienced with radiation instruments is that it is extremely difficult to obtain a surface of metal free from slag and oxide films. Unless this is done the readings are unreliable.

(4) *Optical Pyrometers.*—The optical pyrometer has found considerable use in operations of annealing, reheating, etc. While many of the cheaper instruments, in which the light radiated from a hot body is compared against a standard colour, are not to be relied upon to any great accuracy, instruments such as that made by the Cambridge Scientific Instrument Company, in which the light radiated from the hot body is compared with that from a standard lamp, can be considered reliable to a matter of well under 1 per cent. To obtain reliable readings from an optical pyrometer it is necessary that "black body" conditions be present. Since these do not apply to metal in a crucible some correction is necessary.

Optical pyrometers are affected, probably to a greater degree than radiation instruments, by the slag and fumes which are generally on the surface of molten brasses.

To sum up the various instruments as far as foundry work is concerned, the thermo-couple and resistance pyrometer must be used with a sheath and are hence too slow, while radiation and optical instruments give unsatisfactory readings on account of the slag and fumes. To be really of service in the foundry a pyrometer should have the following characteristics:—(*a*) It should be accurate within 1 per cent. This means a maximum error of 10 deg. at 1,000 deg. C. (*b*) It should be capable of use up to 1,300 deg. C. if required. (*c*) It should be direct reading and involve no calculation whatever. (*d*) It should indicate the temperature of molten metal within, at most, one minute of immersion. (*e*) It should be strong and not easily put out of order; or at any rate, it should permit of easy and cheap repair. (*f*) It should not be too expensive.

I am strongly of the opinion that an immersion method is the only one of any use for molten metal, and further that the couple must be used either bare or with only a wash of refractory material on it.

Platinum is much too expensive. Iron and alloys of iron are too readily dissolved by the molten metals. The only commercial alloys left are those of nickel. For some time back a couple has been made in America of which one element is almost pure nickel and the other an alloy of nickel with about 9 per cent. of chromium. This gives an E.M.F. of over 40 millivolts at 1,000 deg. C., so that a robust galvanometer can be used with it. The two wires are encased for most of their length in a steel tube, leaving only a few inches of bare wire for immersion. Inside the tube they are insulated from each other by asbestos woven to a tubular form, or by pieces of porcelain tube.

I have used such a couple regularly for over a year and have found it very satisfactory. In the brass foundry at Cathcart the temperatures are taken of all melts of manganese brass and of all melts of gunmetal from which important castings are made. The wires are welded together and when the junction is burnt through they can be rewelded in a couple of minutes in the oxy-acetylene flame.

In molten brass or manganese-brass at 950 to 1,000 deg. C. the couple lasts a very long time. In molten gunmetal the life of the junction depends on the temperature of the metal. At temperatures of 1,300 deg. C. and over the junction will only last one or two immersions, but at 1,150 to 1,200 deg. C. perhaps 8 would be an average. The amount by which the couple is shortened each time the junction is burnt through is only 2 in. at most, so that the actual cost of each immersion is very small.

I do not intend to dwell at length on the effect of casting temperatures since this Paper is only concerned with the measurement of these. I might just mention the results obtained on gunmetal of composition roughly:—88 per cent. copper, 9 per cent. tin, 2.5 per cent. zinc, 0.5 per cent. lead. When cast at 1,300 deg. C. the strength is approximately 9.5 tons per sq. in., at 1,200 deg. C. 13 tons per sq. in., reaching a maximum of over 16 tons at 1,150 deg. C. At temperatures of 1,050 deg. and under the bars are unsound. One might imagine that the range of temperatures within which gunmetal is cast in foundries would be comparatively small. I am quite convinced that in the average foundry the casting temperature varies from about 1,100 deg. C. up to 1,300 deg. C. At Cathcart we have found that the casting range of manganese brass is very small, and that for the soundest castings the temperature should be 970 deg. C. $\pm$ 20 deg. C.

In conclusion, I would like to say a word about the upkeep of pyrometers. In works where a large number is kept their repair and calibration becomes an important matter. While some pyrometers work satisfactorily for long periods without attention others most decidedly do not. If no indication whatever is given on the instrument the trouble may be due to:—(1) Hot junction burnt through. This is evident at sight. (2) Insulation of thermo-couple defective. This is easily tested by trying on a millivolt-meter. (3) Bad contact between thermo-couple and instrument.

If the readings are incorrect the error may be due to:—(1) Alteration in resistance of couple, possibly caused by its length being reduced. (2) Instrument out of balance. (3) Alteration of tension in hair spring of instrument.

I might briefly describe an arrangement which Messrs. Kelvin Bottomley & Baird made for me

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for testing galvanometers. The instrument used for checking is a sub-standard millivolt-meter. The system is that the current from a dry battery, controlled by resistances, is sent through both the standard millivolt-meter and the instrument to be tested. Any disagreement is at once noted. On this switchboard are placed resistances to suit all the various types of couple used, and also small resistances to compensate for the varying lengths of the couples. By this arrangement an instrument can be calibrated in a few minutes over its entire scale and making allowances for any length of couple.

Future Research on Cast Iron.*

By J. H. Andrews, B.Sc.

The application of the microscope to the iron foundry is now too well known to require reiteration of its claims upon the practical man. Unfortunately, it is the common impression amongst foundry men that the microscope represents the last word in scientific research. This is largely accounted for by the fact that the scientist, whose business it is to give us new methods, has been extremely backward in employing his energies upon foundry practice, partly from lack of encouragement and partly on account of the complex problems involved.

The microscope has its limitations; it does not, for instance, enable us to distinguish silico-ferrite or manganese-ferrite from pure ferrite, nor silico-carbide from pure iron-carbide. One is, moreover, restricted to examinations in the cold. It is, up to the present, impossible to follow the changes that occur during heating or cooling; one can only observe the ultimate result of the same. What is really required is not so much the evolution of new methods, but the application of those in existence, such as are now largely employed in connection with steel research. As examples of the methods referred to, let us consider the value of thermal dilatation, electrical resistivity, and magnetic determinations.

Thermal Determinations.—If we were to take a number of cast irons, of various compositions, so arranged that we have several complete series in which but one element alone varies at a time, and take series of freezing curves at different rates of cooling (of each composition), we can arrive at a fairly complete understanding of the effect of the different elements upon the constitution. If, for instance, a series with varying silicon had been taken, it would have been found that when the silicon content had reached a certain value, a curve similar to the freezing curve of a pure iron resulted. This would at once have told us that silicon, by precipitating the graphite from solution, had entirely eliminated it from the sphere of action. Moreover, by adopting standard rates of cooling, the very magnitude of the critical points would provide data of considerable value. Thus, by means of half a dozen or so curves taken in this way in the laboratory, all the results produced by numerous practical experiments, involving great cost, could readily be arrived at.

Dilatation Curves.—The fact that dilatation curves, or curves showing the expansion and contraction on heating and cooling, have proved themselves of great value in steel research is alone sufficient recommendation for their trial on cast-iron problems.

Low-temperature changes, which are rarely shown up on thermal curves, in most cases give rise to a marked kink in the dilatation curve; indeed, in steel-works laboratory experiments I found this instrument to be, perhaps the most useful of all for physical measurements. The actual results and value of such determinations can, of course, only be arrived at by actual experiment, but one problem in particular presents itself above others with reference to the growth of cast iron. By observing the expansion and contraction during heating and cooling at different rates, and changes in volume occurring during soaking, it should be possible to arrive at a complete explanation of this phenomenon. True, much work has been done on these lines, but much still remains.

Electrical Resistivity Determinations. — Any marked changes in constitution occurring during heating or cooling are very clearly shown up by a temperature-resistivity curve. For instance, the deposition of graphite or temper carbon would produce a marked increase in the electrical resistance. Would not this, then be an excellent method to use in the case of malleableising practice? It would give us at once the temperature at which carbon began to be deposited, and also the temperature of maximum rate of deposition.

One often notices, in microstructures of cast iron, that the graphite in certain places appears to have crystallised out in the form of parallel plates running in the same direction. If it were possible to produce this directional separation at will, in order to produce a casting of greater strength along one particular direction, it would be found that the electrical resistivity was greater in the direction across these plates than along them. Resistivity measurements, then, provide us with an excellent method of testing for the regular distribution of graphite. Any heterogeneity would be shown up by this test. However, it is often used for the detection of unsoundness in steel ingots.

Magnetic Determinations.—Although these are now largely employed in America for the detection of flaws in steel bars—measurements being taken along their length—the application of this method is not quite so apparent, excepting in so much that it is still untouched ground, and may reveal anything.

Investigations on Cupola Slags.—The blast-furnaceman is largely guided in the working of his furnace by the character of the slag. A great deal of scientific work has been recently carried out in America upon this subject, and all experiments have gone to show that the constitution, and in particular the viscosity, of the slag is of paramount importance.

I was once consulted with regard to iron castings which were coming out badly blown; the blow-holes did not show up until after machining, and were all bright. The metal in the ladle had the appearance of being particularly gassy. I then inquired into the running of the cupola, and was told that the only alteration that had been made on past practice was that additional lime was being used. My report on the matter was to the following effect:—Silica has a strong affinity for FeO, but a stronger affinity for lime; therefore, when excess lime was added the silica was insufficient to combine with all the oxide of iron in the metal, with the result that the included oxide, by combining with the carbon of the metal with the

* Paper read before the Institution of British Foundrymen, Annual Conference, Glasgow, 1920

formation of CO, gave rise to blown castings. Less limestone was then added, and all went well.

This illustration is given merely for the purpose of showing the importance of correct slag conditions, and how necessary it is for us to know more about this question.

One expects to hear the comment that the line of work suggested is of an altogether theoretical nature, and can lead to but little advancement in practice. Perhaps the best way to disperse that idea is to mention that during my term of office in a steel-works research laboratory I gradually worked things to such a pitch that, wherever it was possible, before any new steel was placed on the market, a complete series of determinations such as have been mentioned, along with mechanical tests, Brinell-hardness determinations, and practical heat-treatment tests based upon the results obtained, were always carried out, and moreover this was done invariably at the request of the practical man in the works, who in the end came to rely upon their results for his practical treatment.

In conclusion I should like to say a few words upon research work in general. My advice to anyone contemplating carrying out research work —in particular, those who think of starting a works laboratory—is, "Do the thing thoroughly." Given adequate equipment and a highly-trained staff, your laboratory will more than pay for itself in a few years; but remember that research work takes time. Do not expect results too soon. On the other hand, half equip your laboratory, place it in the hands of a semi-trained man, and you will soon prove to your own satisfaction that research work is a waste of money. No doubt, much can be obtained from little material, but if you are out for the bigger things you must do the thing properly. Science is a coy maiden; she will not be trifled with.

ALUMINIUM LIGHT ALLOYS.—In a lecture on the "Micrography of the Minor Constituents of Some Commercial Aluminium Light Alloys," given before the Birmingham Metallurgical Society, on December 6, Mr. C. J. Wills, of Birmingham University, referred to the difficulty which attended the investigation of the behaviour of various constitutents in the case of aluminium alloys. Mr. Wills explained that in commercial alloys of aluminium various metals were added with a purpose, but there were two elements—iron and silicon—which were always present, and, though not always desirable, it was found impossible to get rid of them. Ordinary commercial aluminium probably contained about 0.5 to 0.6 per cent. of iron, and perhaps about 0.3 per cent. of silicon, and these elements, even in small quantities, influenced in a profound way the structure as seen under the microscope. As these two metals were unavoidably present in aluminium, it was not therefore possible to determine the influence of either one of them or any other element in a binary system, as was most desirable, but at best only in a ternary system. That was to say, in investigating the effect of iron there was the complication due to the presence of silicon, and in investigating the effect of silicon there was the same difficulty owing to the presence of iron. The lecturer then outlined what was known as to the behaviour of iron and silicon in small quantities with aluminium, and the effects of subsequent heat treatment on the properties of the alloys, and went on to discuss the influence of the other important constituents in the most useful aluminium light alloys—viz., copper, zinc, and tin—and with the effects of these in varying proportions and under different conditions, illustrating his references to the microstructure by lantern slides.

The Basset Direct Steel Process.

With all due reserve—because it has been the common experience of the iron and steel trade that no direct process of the many hundreds that have been invented has ever been of practical use—we print the following translation of an article which appears in the Paris "Information" of August 1 and other French papers.

A new company has been formed in France under the title of Société Française des Aciéres Basset, with a share capital of 60,000,000 fcs. (£2,400,000 at par), to work the patent rights secured by M. L. Basset, which, according to the report of the Commissaire aux Apports submitted to the recent general meeting of the shareholders, includes a direct process for making iron and steel.

As remuneration, M. Basset receives one-half of the ordinary fully paid-up shares (60,000 of 500 fcs. each) and 30,000 founders' shares, besides a sum of 275,000 fcs. (£11,000). In case of an increase in the share capital one-half of the new fully-paid shares are also to go to the vendor of patent rights, who in consideration of the remuneration received cedes also all his rights under two agreements, one with an iron mining company probably the Société Française des Mines de Fer) for the supply of a large tonnage of ores, and another for the purchase of a "pre-installed" works in which the Basset processes can be rapidly developed. The total increase in the capital, however, must not exceed 150,000,000 fcs.

The Basset process—concludes the Commissary's report—has passed the stage of patent specifications, as it has already been tried on a commercial scale, though small, and thus the direct steel process so much sought for has finally been realised. There are three sets of apparatus required in the cycle of modern steel-making operations; two of these, the blast furnace and converter, are replaced in the Basset process by an apparatus which is extremely simple in construction, and inexpensive, with low consumption of raw materials and cheap working.

As regards distribution of profits: A dividend at the rate of 8 per cent. is to go to the shares, and after the payment of the statutory sums to the reserve fund and in directors' fees, 95 per cent. of the balance is to go to the ordinary and 5 per cent. to the founders' shares.

The Board of directors includes M. Basset himself, and a namesake; three ironmasters; a director of the Belgian Ougrée-Marihays Company; the President of the Société Française des Mines de Fer; M. Jarry, the administrateur délégué of the Tréfileries du Havre, and others.

The preliminary trials were carried out at Mantes, in the old Lavocat Works, with a furnace specially adapted for the purpose. It is reported that the daily output was 25 tons. A plant comprising six furnaces of 250 tons each is said to be in course of construction at Longwy, and will be ready to start producing within six months. Another plant with a daily output capacity of 2,000 tons is said to be building in Normandy, and will begin to produce in about a year's time.

A NEW RESEARCH ASSOCIATION. — The Secretary of the Department of Scientific and Industrial Research announces that the Research Association for the Cutlery Industry has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the Association is to be registered as a non-profit-sharing company, the promoters have applied to the Board of Trade for the issue of a licence under Section 20 of the Companies (Consolidation) Act of 1908. The Secretary of the Committee engaged in the establishment of this Association is Mr. W. H. Bolton, P.O. Box 49, Sheffield.

Breaking-up Large Feeder Heads for Re-Melting.

By the courtesy of Messrs. Glenfield & Kennedy, Limited, engineers and ironfounders, Kilmarnock, we are enabled to give the following description of the method adopted in their works for breaking up large and bulky scrap into a form suitable for re-melting in the cupola.

In their principal business as hydraulic engineers, Messrs. Glenfield & Kennedy, Limited, are continually producing large, heavy hydraulic rams and cylinders, and a special casting-pit has been provided in their foundries for this purpose (described in our June issue).

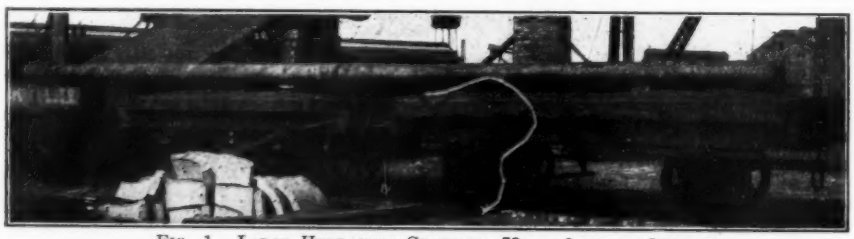

FIG. 1.—LARGE HYDRAULIC CYLINDER, 39 FT. 8 IN. IN LENGTH.

Fig. 1 is a large hydraulic cylinder having an overall length of cylinder and feeder head of 43 ft. 5 in., while the length of cylinder itself was 39 ft. 8 in. The combined weight of cylinder and head was 5 tons 12 cwts., designed for a working pressure of 750 lbs., and to withstand a water pressure test of 2,500 lbs per sq. in.

FIG. 2.—HYDRAULIC CYLINDER CASTING. HEADER PREPARED FOR BREAKING UP.

One of the essential features in obtaining these castings of the requisite degree of soundness and freedom from porosity is the provision of a large sinking-head. The breaking-up of these sinking heads preparatory to re-melting was one of the problems with which Messrs. Glenfield & Kennedy were confronted. These heads are too large and massive to be broken successfully by means of the usual drop-weight or tup, and on this account it was necessary to employ dynamite cartridges for bursting the heads. A reference to the accompanying illustrations explains the method adopted. Fig. 2 shows a large head drilled and the cartridges inserted in position preparatory to firing. The cartridges are connected to an ordinary hand-magneto firing-device. Fig. 3 shows the same sinking head immediately after firing the cartridges, the head having been split into two portions. The total weight of the head was 5 tons 3 cwts., and the total area at the plane of rupture was approximately 1,470 sq. in. The rupture was effected by two successive explosions, each of 2 lbs. charges of explosives. Fig. 4 shows the fracture of the header.

The heads burst in this manner are finally broken up, using the ordinary drop weight or tup.

The breaking up of large feeder heads and bulky masses of metal in this manner is more conveniently and rapidly carried out than by melting, as is sometimes adopted in reverberatory furnaces. Messrs. Glenfield & Kennedy, in their practice have experienced no danger from flying fragments, the fear of which often prevents the adoption of this process by foundrymen.

In the large sinking cavity or "pipe" which is opened upon the breaking of these headers well-formed crystals are frequently formed. The crystals which are of the typical "pine tree" type, though not so largely developed as in the case of steel ingots. Some perfect specimens have been obtained at various times.

FIG. 3.—HEADER IMMEDIATELY AFTER FRACTURE BY EXPLOSION.

MICA IN SOUTH AFRICA.—A new mica mine has been opened in the Barberton district, South Africa, immediately to the north of the Sheba railway bridge. From workings already undertaken it appears that a superior bed of mica, not less than 15 ft. thick and up to at least 25 ft. as a maximum, has been struck 400 ft. below the outcrop. Judging from the quality exposed, there should be a sufficient tonnage in sight to establish a permanent industry.

Growth of Grey Cast-Iron.

In the Journal of the College of Engineering, Tokyo Imperial University, Japan, for February, 1920, M. Okochi and N. Sato publish a paper on the growth of grey cast iron. It is commonly understood that when grey cast iron is subjected to repeated heatings it increases in volume, and this increase is due to the internal oxidation of various constituents on account of the gradual penetration of oxidising gases from the exterior surface into the centre of the material. Those authors, however, from the results of experiments, have arrived at conclusions which they maintain confirm the theory of growth based on the pressure of occluded gases.

In summarising their conclusions they state that there are two causes of growth in grey cast iron, one occurring at temperatures higher than that of the transformation, and the other during the transformation. The first case is explained as the permanent expansion of cast iron due to the pressure of occluded gases. If a specimen is kept at constant temperature higher than that of transformation, it gradually elongates up to a certain limit, after that no growth is observed unless it is heated to a higher temperature, or cooled below the transformation temperature and again heated. In grey cast iron there are numerous flakes of graphite which absorb a fair amount of gas and are surrounded by many spaces filled with gases. Therefore, when cast iron is heated to a high temperature the pressure of the occluded gas, whatever its initial pressure, is greatly increased. By keeping the specimen at this high temperature plastic deformation takes place, rapidly at first, then slower and slower as the pressure of the gases, reduced by increasing volume, equalises the resistance of the material. Raising the temperature of the specimen upsets the equilibrium between the resisting force of the cast iron and the pressure of the occluded gases, so that deformation again takes place as a double effect of the increase of pressure on the one side and the reduction of resisting force on the other. When the specimen is cooled from a high temperature, the gas pressure is quickly reduced to a pressure lower than atmospheric, the coefficient of contraction of occluded gases being 300 times greater than that of cast iron, and this facilitates the penetration of gases along the flakes of graphite from the surface of the iron.

The growth produced during transformation is also considered due to the pressure of gases. The transformation of the material is the change of molecular configuration, and a certain amount of contraction is required during the structural change of alpha iron to gamma iron by heating. The pressure of occluded gases resists the contraction during the molecular change, so that the time required to meet the transformation must be extended. This necessitates repeated heatings, and when the quantity of occluded gas is increased by repeated heatings the resistance to contraction increases and contraction becomes smaller.

Those results are deduced from a study of the dilation-temperature curves on heating and cooling, the magnetisation-temperature curve, the weight-temperature curve, and the micro-structure of a grey cast iron. Similar curves were obtained in air and in a hydrogen atmosphere. The authors claim this latter point as a proof that growth does not depend on oxidation of the constituents.

White cast iron has no growth, as no free carbon exists, and accordingly no room is allowed for expansion of the gases, and no passage along the graphite flakes for penetration of the gases.

Prevention of growth, it is stated, may be brought about by decarbonising the surface in order to close the passage against penetration of gases along the flakes of graphite. As the occluded gases are not removed, however, growth produced after one heat is unavoidable, and is always to be expected on proper annealing.

FIG. 4.—HYDRAULIC-CYLINDER HEADER SHOWING FRACTURE.
MESSRS. GLENFIELD & KENNEDY, LIMITED.

"SAFETY FIRST."—At the Machine Tool Trades Exhibition, which was opened last Saturday at Olympia, a Convention will be held under the joint auspices of the Home Office and the British Industrial "Safety First" Association. There will be two sessions, at which papers of interest will be discussed. Engagements permitting, the Home Secretary will preside at the morning session and Lord Leverhulme in the afternoon. Invitations to the Convention are being extended to the managements and workers of the principal industries throughout the country.

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NOTES AND COMMENTS.

Industrial League Summer Convention.

The major portion of the "Industrial League Journal" for July is taken up with the report of the two days' convention held at Manchester. The *résumé* of the discussions which took place there typifies the comprehensive conception the League and Council holds of its duty towards all phases of the industrial community of Great Britain in relation to its activities to promote industrial harmony. Papers were read at the convention by Mr. H. G. Williams, M.Sc., M.E. (Liverpool), A.M.I.E., on "Currency, Credit, and Foreign Exchanges and their Relation to the Cost of Living"; by Mr. F. S. Button, A.S.E., member of the Industrial Court, on "Payments by Results"; and Mr. J. D. Steven, on "The Functions of Works Committees." Each subject was exhaustively debated, and it is safe to assume that the ministrations of the League and Council in Manchester cannot but have a powerful influence on the industrial life of that city.

British Chemical Standards.

The unification of analysis and the methods adopted for this purpose are of vital importance to the iron-founding industry. Practical foundrymen, engineers, and users of castings are frequently perplexed by the difficulty of reconciling analytical figures obtained by two or more analysts, and what is more significant this difficulty has frequently occurred in the case of figures supplied by various analysts of considerable repute.

During the recent war period when so many firms were called upon to work to various chemical specifications this difficulty became very widely apparent, and the curious situations which frequently arose are still in the minds of most foundrymen. The need for some form of standardisation was widely felt, and amongst the various official bodies who took up the question, the work of the British Chemical Standards movement desires widespread acknowledgement.

The use of standard samples of steel, the composition of which has been repeatedly checked by a variety of methods and often by various analysts, has been practised for some considerable time in the comparative colorimetric determination of combined carbon by the Eggertz method. In this country, however, the adoption of similarly prepared samples, of universally acknowledged value, for the purpose of standardising the methods for other constituents has not been extensively carried out. In America the adoption of standard samples has been more widespread, and authoritative standards are issued by the Bureau of Standards under the auspices of the Government.

The value of standard samples containing a known quantity of any particular element which has been accurately determined and checked by the various methods in common use for that particular element, as a reliable means of ensuring the unification of results obtained, will at once be realised, and it will be perceived that the universal adoption of some such standards offers one of the readiest means of overcoming variations resulting from such features as inaccuracies in weights, in standard solutions, and certain errors which often arise in so-called rapid methods. Probably the most valuable aspect of the universal adoption of standard samples is the effect it would have in tending to eliminate much of the uncertainty and confusion which not infrequently arises when comparing notes respecting the chemical composition of irons and steels.

Confining our attention for the moment to cast iron with which we are more nearly concerned, it should not be overlooked that the difficulty regarding the unification of chemical analysis in this connection is more pronounced than in the case of steel and other ferrous materials, and, unfortunately, the largest variations are found in the values obtained for the most vital constituent—the carbon-content. It has long been

realised that this is not so much a matter of the actual chemical procedure in the determination of the constituents as in the method of sampling and obtaining the sample drillings. It is not intended to imply that difficulties of this nature are to be overcome by the use of standard samples for checking purposes. It has long been known that this difficulty can only be met by the adoption of some standard methods of sampling. This, however, does not affect the value of the standard samples in ensuring unification of the results obtained in the actual estimation of the constituents

The report of the first three years' working of the British Chemical Standards Movement only partially conveys to the lay mind the extensive spadework which has been done by the movement and its co-operators since its inauguration in 1916. Some ten or a dozen samples have been prepared, standardised, and issued, amongst which it is important to note are two standard cast-irons of the low-phosphorus, hematite type. The standards have been prepared and the compositions determined and standardised by an imposing list of co-operating analysts, including referee analysts, Government Departments, works chemists in various branches of the industry.

Quite apart from the preparation and issue of the standards themselves, one thing absolutely necessary to progress towards the unification of analysis has been the arousing of interest in the subject, explaining the uses and value of standards, and generally combating apathy, prejudice, and ignorance, both in chemists, engineers, and others. Considerable assistance has been given in this aspect of the question, according to the report by three of our British Government institutions, and besides they have agreed to co-operate with future standards and have tested those already in use. Some assistance has also been given by the Bureau of Standards at Washington, and the movement has the personal interest of Dr. Hillebrand of the Bureau.

Whilst at the present time the British Chemical Standards has the widespread co-operation of many chemists and official bodies, official recognition on the part of our leading engineering and metallurgical institutions which, after all, are primarily concerned in this matter, does not appear to have been yet obtained. For this reason, therefore, it is obvious that the last word regarding the preparation and issue of standard samples has yet to be said. It will, however, be fully recognised, whatever happens in the future, that it is owing to the pioneer efforts of the British Chemical Standards Movement that both official and unofficial circles have been effectively roused, and for these initial steps, which so far have produced so eminently satisfactory and practical results, the whole country, and more particularly foundrymen, are deeply indebted.

Effect of Machining Malleable Cast-Iron.

In a Paper before the recent twenty-third annual meeting of the American Society for Testing Materials at Asbury Park, N.J., on "Effect of Machining and of Cross-Section on the Tensile Properties of Malleable Cast Iron," Mr. H. A. Schwartz supplied data as to the variations in the tensile properties of malleable cast-iron with increase in cross-section, and also as to the effect of removal of the surface metal upon the tensile properties. These data were graphically expressed by the author. Equations of the curves showing the relation between the tensile strength and percentage of elongation and the diameter of rough and machined specimens were also given. As a result of the tests performed the author drew the following conclusions: (1) Decarbonisation has a favourable influence upon the strength and ductility of the product; (2) the effect of quick cooling in freezing on the surface metal of a casting is such as to improve the strength and ductility of the product: (3) roughness of surface of a cast specimen apparently decreases the strength and especially the ductility; (4) the ultimate strength decreases with increasing diameter of section by an amount proportional to the cube of the diameter; (5) the elongation decreases by an amount proportional to the $2\frac{1}{2}$ power of the diameter; (6) the combined effect of all three of the preceding variables on strength amounts to about 7,000 lbs. per sq. in. for sections $\frac{1}{4}$ in. in diameter or less, and becomes negligible at diameters of $1\frac{1}{4}$ in. or over; (7) the combined effect on elongation is about 3 per cent. for small specimens and negligible for diameters above $\frac{3}{4}$ in.; and (8) the yield point is apparently not affected by any of the variables investigated.

Cast-Iron Pipe Made with Electric Furnace.

A new product—in the form of the M'Kane Prepared-Joint Electric Cast-iron Pipe—which is a method of manufacture they have been experimenting on for five years, has been announced by the American Cast-iron Pipe Company, of Birmingham (Ala.). It is stated that the iron for this pipe is superheated in an electric furnace. Experiments have shown that uniformly high-temperature iron was the secret of making light-weight pipe to withstand the same pressure as thicker-walled pipe of the present standards. Though it is found that high-temperature iron cannot be produced satisfactorily and dependably in cupolas, with an electric furnace uniformly high tensile-strength castings were made. Molten iron from both the cupola and the blast furnace is combined in the electric furnace to obtain the proper analysis; and then the temperature of the mixture is raised to a higher degree than is possible in the cupola. The high sulphur increment which is incident to cupola iron is thus avoided, and essential metalloids usually lost in cupola practice are saved. Undesirable gases are freed from the metal by the agitation set up by the electric current, so that the chemical properties, as well as the temperature of the iron, are better controlled by the electric current passed through the furnace arcs. The result is a molten iron mixture low enough in carbon and silicon to ensure high-tensile strength, and hot enough to make good thin-section castings. The standards usual for electric pipe are:—Tensile strength, 30,000 lbs. per sq. in.; transverse strength, 2,600 lbs.; deflection, 0.38 in. After several years spent by the research department of the company in seeking a simplified and more efficient joint, the M'Wane prepared joint has been evolved. To make a joint in the trench with this factory-made joint, it is necessary only to insert a plain end into a bell, and caulk the lead. It is constructed on a new principle which makes it tighten when deflected. The joint is made at the factory by standing the pipe on the spigot end, and inserting a mandrel into the bell. A band of iron wedges held together by a strip of lead is first inserted around the mandrel. Two layers of square hemp, specially braided for the purpose, are next inserted and caulked on the top of the wedges. Then hot lead is poured into the joint, and the mandrel extracted—leaving all the joint materials in place. A concrete plug is inserted, to protect the joint materials in shipment.

We understand that a pattern-making business has been established under the name of Furmston and Lawlor, engineers' pattern makers, at Birds Hill, Letchworth, Herts. Mr. Lawlor has had a lifetime's experience of high-class pattern making, and has been for the last fifteen years charge hand with Messrs. Peter Brotherhood, Limited, of Peterborough.

FRENCH IRONFOUNDERS SYNDICATE. — In his inaugural address, M. Ernault, who has been elected President of the Syndicate of French Boilermakers and Ironfounders, referred to the need for co-operation with other syndicates, especially with the Association of Metallurgical and Mining Industries. The members of his syndicate required raw materials at the lowest possible prices, while the manufacturers wanted to sell them as dear as possible. It was therefore essential for them to form a compact body to be able to negotiate on better terms with the Comité des Forges de France.

XUM

Steel Foundry at the Works of the Austin Motor Company, Limited.

The new steel foundry at Longbridge Works was not laid down with a view to meeting the full demands of the works for general castings, but rather to ensure an adequate supply of special castings, which owing to their nature are somewhat outside the scope of, and therefore not readily obtainable from, steel foundries. The foundry building is 750 ft. long by 200 ft. wide, being covered by one central and two side bays. There is very ample top and side lighting, and the floor is paved with cast-iron plates. Standard railway track is laid along both of the side bays, to

A central position in the melting bay is taken up by the other two, each of 20 cwts. melting capacity. They are blown by motor-driven Roots blowers. Adjacent are two Morgan crucible furnaces for melting up the additions.

At the side of the furnaces is the stocking ground for the pig-iron and scrap, which is brought in by rail and discharged into bogies, which can be delivered at any portion of the stocking ground along a line of track and branch tracks laid at right-angles to the main track.

A proportion of the sand is discharged from the

FIG. 1.—GENERAL VIEW OF FOUNDRY. AUSTIN MOTOR COMPANY, LIMITED.

one of which the raw material is delivered, while from the other the finished castings are loaded up.

Naturally the foundry has been laid down on the most modern lines, due regard being given to that most important essential for "mass production"—a perfect continuity of operations. In the general equipment and working of the foundry many innovations have been made, so far, at any rate, as this country is concerned; the foundry, indeed, is representative of the best British and Continental practice.

Engaged upon repetition work, whitemetal pattern plates are employed exclusively, and moulding operations have been so simplified as to bring them within the scope of the unskilled labourer; in point of fact there is not a skilled moulder employed in the foundry. The whole of the moulding is done in Belgian sand, which is used green, while the design and arrangement of the pattern-plates is such as to almost entirely eliminate the use of cores, as will be referred to later in the article.

trucks into a series of brick hoppers each of 50 tons capacity, with openings feeding on to the mixing-mill floor; the remainder of the sand is discharged into a similar series of bins. The sand-mixing plant consists of three runner mills, which were designed by Mr. George Fosseprez, the foundries manager, and are a distinct departure from standard practice in this country. One of the rolls is plain and the other corrugated, and whereas it is customary to employ rolls weighing from a ton up to so much as two tons, the rolls in question each weigh 10 cwts., Mr. Fosseprez rightly pointing out that the mills are for mixing and not for grinding the sand.

From the mills the sand is raised by a bucket elevator to the disintegrator, from whence it falls down a shute into hoppers mounted on bogies, and having a capacity of about 30 cwts. The bogies are wheeled along a track into the side bay, from whence the hoppers are conveyed by a 2-ton crane to any one of the moulding machines.

The proportion of the sand required for drying is raised from the hoppers by a bucket elevator, and fed to an Edgar-Allen rotary dryer, through which from 30 to 40 tons per day can be passed. From the dryer the sand falls down a shute on to a worm conveyor, which delivers it with the wet sand to the mills. Sand from the foundry is tipped down shutes on to the mill floor. The sand dryer is driven by a 5-h.p. motor, the elevator by a 3-h.p. motor and the mills (each mill, with its elevator and disintegrator, being a self-contained unit) are driven off line shafting from a 25-h.p. motor.

A portion of the melting bay is taken up by a general stores, and above these are a well-arranged suite of offices for the foundry manager and his staff; such offices, if not actually unique, are very unusual in a British foundry. Beyond the stores is the general core shop, though, as already stated, the number of cores used is very small in proportion to the output of the foundry.

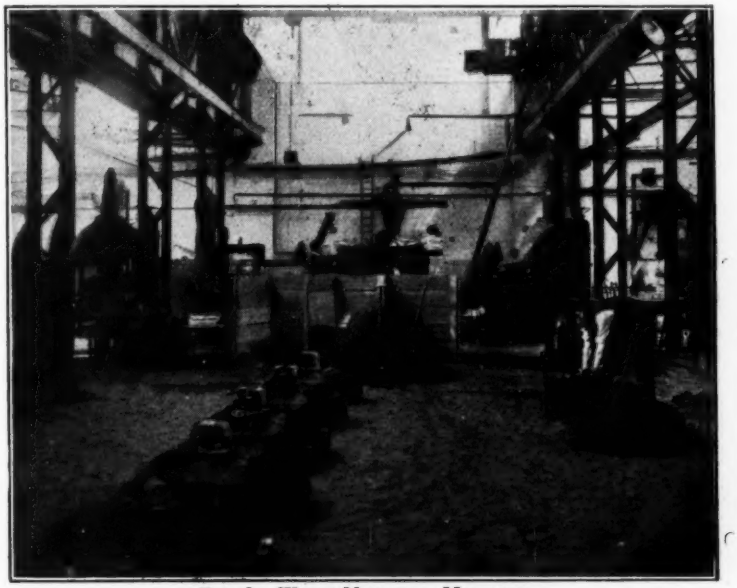

FIG. 2.—WHEEL-MOULDING MACHINES.

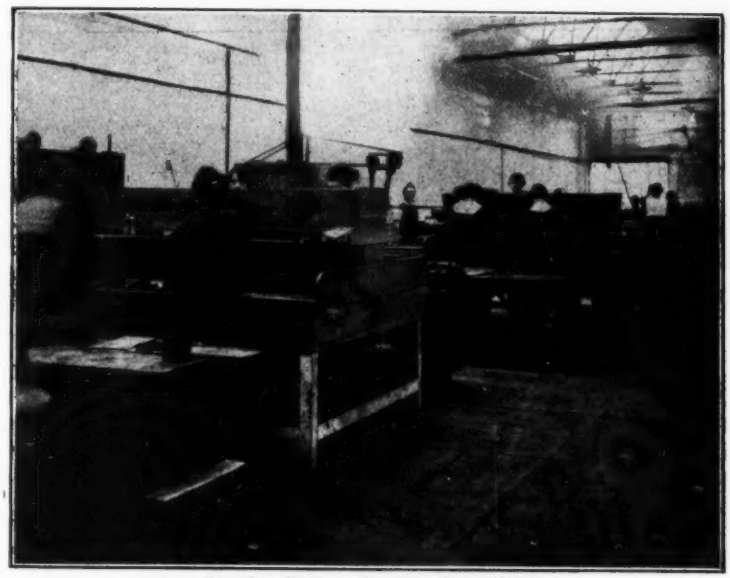

FIG. 3.—VIEW IN GENERAL CORE SHOP.
AUSTIN MOTOR COMPANY, LIMITED.

D

FIG. 4.—PART VIEW OF FOUNDRY, CONVERTERS ON LEFT. AUSTIN MOTOR COMPANY, LIMITED.

FIG. 5.—STOCK CONVERTERS IN MELTING POSITION.
AUSTIN MOTOR COMPANY, LIMITED.

FIG. 6.—FETTLING SHOP.

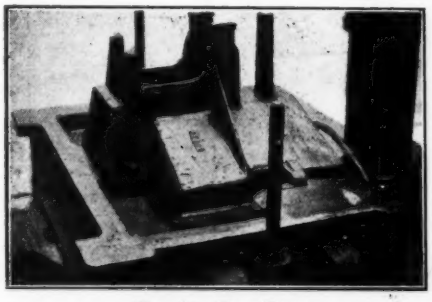

FIG. 7.—TOP PART.

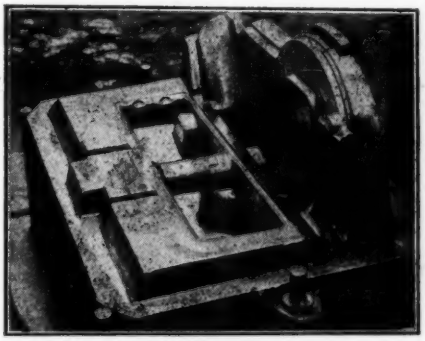

FIG. 8.—LOOSE PIECES IN POSITION.

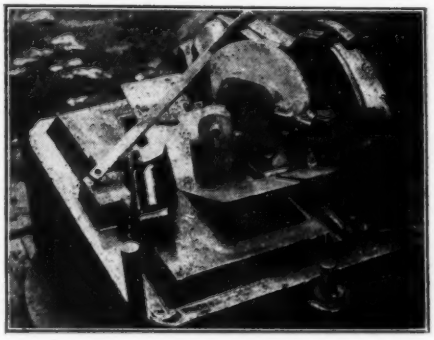

FIG. 9.—PIECES OUT.

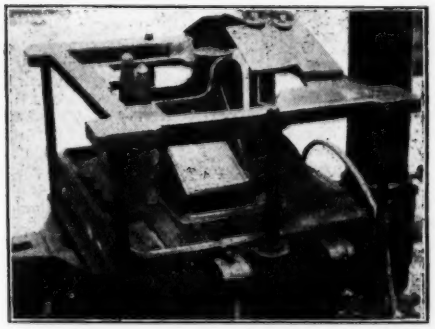

FIG. 10.—STRIPPING PLATE AND LOOSE PIECES OUT.

PATTERN PLATE OF TRACTOR FRONT COVER ON TURNOVER HYDRAULIC MOULDING MACHINES.
AUSTIN MOTOR COMPANY, LIMITED.

XUM

The main bay is served by a 10-ton crane which travels on an upper gantry, and four 2-ton cranes carried on the lower gantry, these last doing the general duties for the bay. There are in all some 23 hydraulic machines, by Bonvillain and Ronceray, Queen Victoria Street, London. Two of these machines are entirely devoted to the production of back axles, and they are served by six turnover machines for making the cores. Another interesting casting made is the front cover for tractors; this is machine-moulded on a turnover hydraulic machine, and cores are dispensed with by the use of four loose parts and two bottom-pushed parts. The stripping plates for these machines are unique, though the practice is adopted throughout the foundry, the plates following the joints wherever they may have to be. It will be understood that the use of such stripping plates and the adoption of turnover machines are responsible for effecting a reduction in the use of cores. Further, the head and pourer is moulded on the machine; for this purpose a metal pattern is used, the bottom of which rests upon a spring, which is of course depressed when the box is rammed and when the pressure is taken off releases the pattern, so that the mould is actually ready for casting immediately it leaves the machine. Headers have been carefully considered with the object of keeping them down to the narrowest limits consistent with the production of sound castings, and this has been accomplished by disposing the headers and feeders in a position most suitable for each particular part. We are able to illustrate interesting examples; in the one instance the weight of the casting is 90 lbs. and the weight of the head 4 lbs. It may be noted that 200 moulds for this particular casting are made by four men in eight hours.

The fettling shop, which occupies a portion of the opposite side-bay to the melting shop, contains two Tilghman's sand-blast houses, and a compressed-air main extends the full length of the shop. There are also two Stein and Atkinson oil-fired furnaces. As the steel used never exceeds 0.15 carbon, annealing is not necessary, and the furnaces are merely used for normalising, the castings being heated up to about 900 deg. C. and allowed to cool out on the floor. Beyond the furnaces is a small machine shop equipped with special cutting-off machines, grinding machines, etc., the finished castings being then loaded up into trucks for delivery throughout the works. It will thus be seen that the continuity is almost perfect, handling being reduced to a minimum.

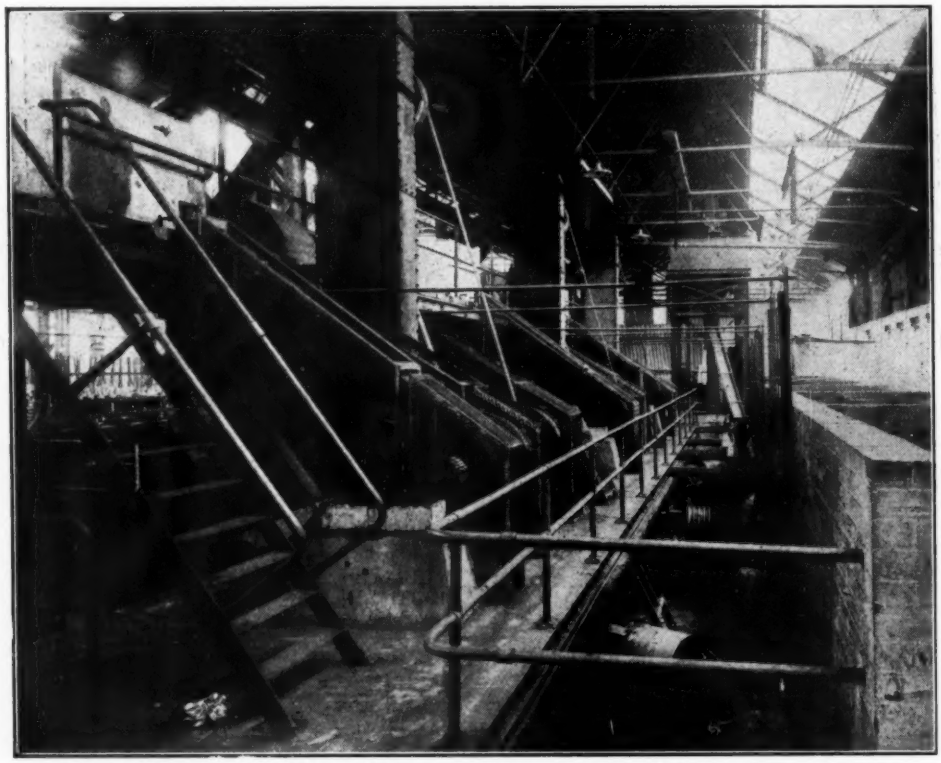

FIG. 11.—VIEW OF SAND-MIXING PLANT FROM FOUNDRY FLOOR. SAND BUNKERS ON RIGHT, ELEVATORS TO DISINTEGRATORS ON LEFT. AUSTIN MOTOR COMPANY, LIMITED.

The foundry power house contains three Alley and MacLellan compressors, each of 500 cub. ft. capacity and driven by a B.T-H. 100-h.p. motor. Two of these sets deliver air to the sand-blast plant at 30 lbs. pressure, and the third supplies the pneumatic tools with air at 100 lbs. pressure. There are also two 3-throw hydraulic pumps (Musgrave Bros., Leeds), each driven by a 50-h.p. B.T-H. motor.

The pattern-plate shop occupies a separate building 100 ft. by 25 ft., and is served by two small Monometer furnaces; two moulders are employed—the only skilled moulders in connection with the foundry. The wood-pattern shop, of a similar size, adjoins. There is also an oil stores, where the tanks have a storage capacity of 50,000 gallons.

Elastic Properties of Bronze Castings.

George F. Comstock.

In commercial practice it has become customary to determine the so-called "elastic limit" or yield point

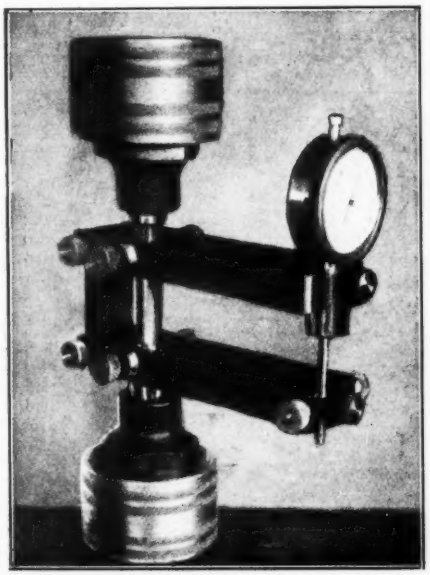

FIG. 1.

chief advantages of this method are its ease of application and the facility with which concordant results can be obtained by different operators on the same material. It is generally conceded that the "drop-of-the-beam" method, which is used for rolled soft steel, cannot be applied to non-ferrous alloys; and if the smallest appreciable deformation is taken as the criterion of the yield point, difficulties are at once encountered in agreeing as to what constitutes an appreciable deformation. Thus the figure of 0.01 in. has been recommended and apparently agreed upon as representing the smallest practical deformation that can readily be measured with dividers in determining the so-called "elastic limit" of non-ferrous alloys.

It is a question, however, whether this determination really gives us any information of value. It is intended, of course, to show the stiffness of the material, and what stress it would safely bear in service without bending or stretching. Yet it is obvious that the yield-point stress as so defined is appreciably more than enough to start deformation in the metal, and there is no way of telling from this determination at what stress the deformation really began. For trustworthy information on this point it is necessary to determine the true elastic limit or proportional limit of the material, and the accustomed use of the yield point in this connection is not correct, as there is no direct relation between it and the proportional limit. Reference is directed to the work of Capt. Mitinsky, Upton, Moore and others.

Elastic Behaviour of Non-Ferrous Metals.

This belief that cast non-ferrous metals do not have any real elastic limit, or any definite limit of proportionality of strain to stress, is one reason for the adop-

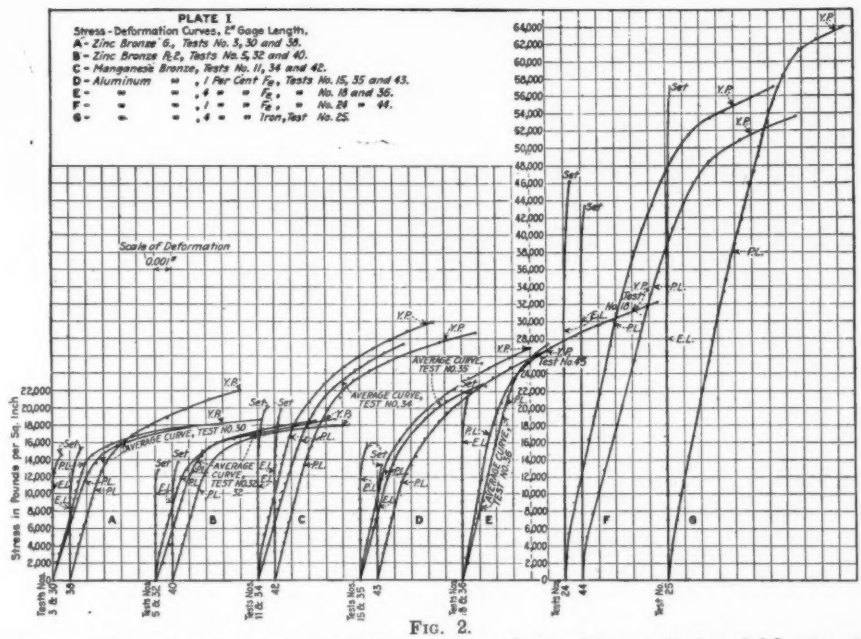
PLATE I
Stress-Deformation Curves, 2" Gage Length.
A - Zinc Bronze G., Tests No. 3, 30 and 36.
B - Zinc Bronze R.E., Tests No. 5, 32 and 40.
C - Manganese Bronze, Tests No. 11, 34 and 42.
D - Aluminum " .1 Per Cent Fe, Tests No. 15, 35 and 43.
E - " " .4 " " Fe, " No. 18 and 38.
F - " " .1 " " Fe, " No. 24 " 44.
G - " " .4 " " Iron, Test No. 25.
Scale of Deformation 0.001"
Stress in Pounds per Sq. Inch
Set
Y.P.
P.L.
E.L.
AVERAGE CURVE, TEST NO. 30
AVERAGE CURVE, TEST NO. 32
AVERAGE CURVE, TEST NO. 34
AVERAGE CURVE, TEST NO. 35
AVERAGE CURVE, TEST NO. 38
Test No. 44
Test No. 25
A
B
C
D
E
F
G

FIG. 2.

of non-ferrous alloys as the tensile stress producing a deformation of 0.01 in. on a gauge length of 2 in. The tion of the arbitrary criterion of 0.5 per cent. elongation as marking the so-called "elastic limit" or yield point to be used in ordinary commercial work. Another reason is the assumption that the determination of the

* Abstracted from Chemical and Metallurgical Engineering, June 16th, 1920.

real elastic limit or proportional limit is too difficult for this class of work, and involves the use of expensive and delicate apparatus and considerable time. Corse and Skillman evidently took this attitude in their Paper on "Manganese Bronze Tests" before the Eighth International Congress of Applied Chemistry (vol. 3, p. 25), for although urging that the usual yield-point determinations on this material are useless, they do not suggest taking the proportional limit instead, and would rely entirely on the tensile strength and elongation. Capp, in his Paper on "Manganese Bronze," considered not only that a delicate extensometer was necessary for proper determinations of the proportional limit, but that the gauge lengths of the test bars should be 8 in. Nearly all authorities agree that this test must be made with spherical-seated holders for the specimen, and with an accurate extensometer averaging the deformations on two or three sides of the bar, and even then it is claimed by some that non-homogeneity of the specimen and inequality of stress distribution may obscure the real effects of inelastic action in the results. Therefore it has come about that proportional limit determinations have been considered as too refined and expensive for the ordinary commercial tests of bronzes, and the easier but almost worthless yield-point method has been retained instead.

Elastic Tests on Bronzes.

During the past few years quite a large number of tests have been made in this laboratory on several types of cast bronze with a view of determining fairly closely their true elastic properties. A variety of alloys was used in this work, but the most complete results were obtained from manganese bronze, aluminium bronze with 10 per cent. aluminium and 1 or 4 per cent. iron, and the common gunmetal or zinc bronze of about 88-10-2 composition. The manganese bronze test specimens were cast in the form of keel-blocks, the aluminium-bronze as plain round bars, and the zinc-bronze specimens were cast in nearly the final size and shape, and fed through a lengthwise fin. The test specimens were all machined to approximately ½-in. diameter between shoulders, and the gauge length was in all cases 2 in. A few tests were made with

TABLE I.—*Results Using Strain Gauge in One Position.*

Test.	Elastic Limit.	Proportional Limit.	Yield Point.	Tensile Strength.	Elongation. per Cent.	Reduction of Area, per Cent.
			Zinc-Bronze, Alloy G.			
1	12,000	14,000	19,000	44,000	38.5	28.6
2	12,500	14,500	19,800	35,800	17.5	20.2
3*	10,500	13,500	18,100	42,000	31.5	31.0
4	9,000	15,000	20,600	38,700	18.5	16.4
Average,	11,000	14,200	19,400	40,100	26.5	24.1
			Zinc-Bronze, Alloy Pc2.			
5*	10,000	11,500	18,400	37,200	26.0	24.8
6	8,500	10,000	21,000	46,200	34.0	26.8
7	10,000	14,000	19,500	46,200	31.0	27.9
8	9,000	13,000	19,800	36,000	15.0	14.9
Average,	9,400	12,100	19,700	41,400	26.5	23.6
			Manganese-Bronze.			
9	13,500	17,000	26,900	74,900	32.0	28.7
10	14,000	17,500	29,800	82,300	22.0	20.9
11*	11,000	16,500	29,700	78,500	17.5	15.4
12	10,000	15,500	26,500	73,400	31.0	28.6
Average,	12,100	16,600	28,200	77,300	25.6	23.4
			Aluminium-Bronze, 1 per Cent. Fe.			
13	12,000	13,000	27,100	67,500	20.0	20.9
14	10,500	12,500	27,500	77,600	21.0	20.6
15*	11,500	13,000	26,900	72,100	20.5	22.2
16	11,000	12,000	25,200	74,300	26.5	27.0
Average,	11,200	12,600	26,700	72,900	22.0	22.7
			Aluminium-Bronze, 4 per Cent. Fe.			
17	17,000	17,500	33,100	84,600	18.5	18.2
18*	16,000	17,000	31,200	68,000	10.0	15.1
19	17,500	19,500	33,000	(Spoiled by flaw)	—	—
20	13,500	16,500	31,300	89,600	25.5	22.6
Average.	16,000	17,600	32,100	80,700	18.0	18.6
			Aluminium-Bronze, 1 per Cent. Fe, Heat Treated.			
21	23,000	28,000	53,500	85,600	12.5	15.4
22	23,000	27,000	55,800	97,400	15.0	19.6
23	29,000	39,000	65,500	92,700	7.5	10.3
24*	29,000	30,000	55,000	95,700	15.5	13.9
Average,	26,000	31,000	57,400	92,800	12.6	14.8
			Aluminium-Bronze, 4 per Cent. Fe, Heat Treated.			
25*	28,000	38,000	63,600	107,400	19.0	21.0
26	36,000	39,000	56,000	90,300	12.0	12.9
27	25,000	39,000	61,300	99,500	11.0	12.9
28	28,000	29,000	57,000	102,900	22.0	22.0
Average,	29,200	36,200	59,500	100,000	16.0	17.2

* Illustrated in Plate I.

specimens having plain ends, and pulled in ordinary wedge grips, but the results obtained in this way were too irregular, and it was soon recognised that the specimens must be pulled in grips having spherical seats through which the tension would be applied without any bending. The grips used here were fitted to receive a specimen with threaded ends, but similar grips intended to engage with extra shoulders on the ends of the specimens would probably be equally satisfactory.

The testing was all done with an Olsen Universal three-screw machine of 100,000-lb. capacity, but the lighter poise reducing the capacity to 10,000-lb. was used for nearly all the work below the yield point in order to increase the delicacy of the load measurements. The autographic mechanism supplied with this machine for drawing load-deformation diagrams was rejected as not being sufficiently sensitive with gauge lengths of only 2 in., and a Berry strain gauge was used in its place.

Results with Strain Gauge in One Position.

In the first series of tests of cast specimens (not heat treated) the loads were applied in increments of 200 lbs., the strain gauge reading for the load was taken, and the load was removed to get the permanent set. This procedure was repeated for each load until the permanent set became about 0.0003 in.; after that the loads were not removed between increments, and the deformation only under load was measured each time. When this became greater than 0.01 in. the strain gauge was removed, and the test specimen was broken in the usual way. The strain gauge was graduated to 0.0002 in., and the readings taken were estimated to a tenth of this value, or 0.00002 in. The stress-set and stress-deformation curves were plotted on cross-section paper to a scale such that 1 in. vertically represented 5,000 lb. per sq. in., and 1 in. horizontally represented 0.002-in. extension on the gauge length of 2 in., or 0.1 per cent. deformation.

Tests on the heat-treated aluminium-bronze test specimens were made in the same way, except that a heavier poise was used on the machine, the increments were 500 lb. instead of 200, and the stress scale used in plotting was such that 1 in. represented 10,000 lb. per sq. in.

The results were obtained from the curves in the following way: The yield point was the stress at which the deformation curve crossed the line representing 0.01-in. extension, and the proportional limit was the stress at which this curve ceased to coincide with a straight line drawn through most of the points at the lower part of the curve. The elastic limit was the stress at which the set curve departed from an approximately vertical direction, sets of 0.00002 in. being generally neglected unless the next set recorded was considerably greater. The tensile strength, elongation and reduction of area were determined in the usual way after removing the strain gauge and breaking the specimen. The moduli of elasticity were also read from the curves, but were not considered reliable, as will be explained below.

The results obtained in this way are listed in Table I., and some of the curves noted by a star and typical of each alloy are also illustrated in Plate I. The figures given represent pounds per square inch, or, in the case of the elongation and reduction of area, per cent.

Results Using Strain Gauge in Three Positions.

In all these tests it was found that the elastic limit was lower than the proportional limit, except in a few cases where both appeared about equal. According to most authorities, however, the elastic limit, if not equal to the proportional limit, should be slightly higher. Consequently the possibility of serious error in the above results was feared, and it was felt that this might have arisen from the manner of using the strain gauge, that is, along one line only of the test specimen. Furthermore, many of the deformation curves were not as regular as might be desired, although the proportional limit was quite distinctly marked in all of them. To check the accuracy of the proportional limits tabulated above, it was therefore decided to test other specimens of these alloys, with the strain gauge applied successively to each of three gauge lines, equal distances apart around the surface of the specimen, for every load used.

Three stress-deformation curves were obtained by this method for each specimen, and they were plotted to the same scale as has been described above. An average curve was also plotted by using the average deformation at each load, and it was always more regular in form than the three curves of actual measurements. The true proportional limit and modulus of elasticity were determined from it, the latter being the stress divided by the extension per inch, for any point on a straight line drawn through most of the points of the lower part of the average stress-deformation curve. The results are presented in Table II. in the same form as before, and typical average curves noted by a star for each alloy are also illustrated in Plate I.

TABLE II.—*Results with Strain Gauge in Three Location*

Test No.	Proportional Limit.	Modulus of Elasticity.	Tensile Strength.	Elongation, per Cent.	Reduction of Area, per Cent.
		Zinc-Bronze, Alloy G.			
29	8,000	11,000,000	33,800	21.5	22.9
30*	11,500	12,500,000	33,600	15.5	13.9
		Zinc-Bronze, Alloy Pc2.			
31	11,000	13,500,000	35,400	22.0	23.9
32*	12,500	12,000,000	39,200	27.0	26.8
		Manganese-Bronze.			
33	18,500	13,000,000	83,200	24.0	22.4
34*	16,500	13,000,000	85,700	25.0	21.8
		Aluminium-Bronze, 1 per Cent. Fe.			
35*	13,000	14,500,000	72,700	29.0	26.1
		Aluminium-Bronze, 4 per Cent. Fe.			
36*	20,500	16,000,000	71,000	9.0	10.4

* Average curves for these samples listed in Plate I.

In explanation of Table II. it should be noted that both of the Alloy G specimens (tests 29 and 30) turned out to be unsound, so that their lower proportional limits as compared with the previous tests (Nos. 1 to 4) might be expected. Also the specimen of aluminium-bronze with 4 per cent. iron had been cast in sand 1¼ in. in diameter, and had been allowed to cool too slowly, so that it was somewhat annealed. This lowered the strength and ductility but raised the proportional limit. With these explanations the proportional limits check in a satisfactory manner those determined by using the strain-gauge as an extensometer.

Results Using Special Extensometer.

Some of the individual curves of the second series were very irregular in their lower portions, on account of the great difficulty of placing the strain gauge on exactly the same marks on the specimen accurately for each measurement. To eliminate this trouble, and to check the elastic limit and modulus of elasticity figures already obtained, an extensometer was constructed that could be kept attached to the specimen till after the yield point was passed, and that would measure the average deformation along two sides of the specimen. The same dial was used in the extensometer as in the strain gauge, and the frame of the extensometer was constructed somewhat on the pattern of the instrument described before the Society

for Testing Materials in 1915 by S. H. Graf (*Proc. A. S. T. M.*, vol. 15, part 2, p. 376). In the instrument shown in Fig. I., however, the motion transmitted from the test specimen to the dial is magnified five times by levers, as is done in the strain gauge itself, so that a unit on the dial represents the same deformation of the specimen, whether it is on the strain gauge or on the extensometer.

Tests were made with this extensometer in exactly the same way as was described above for the first series of tests, the only difference being that the deformations measured in this third series were average deformations from two sides of the specimen instead of being from only one side. The curves obtained in this way were more regular, and determinations were made of the elastic limit and modulus of elasticity as well as the proportional limit, yield point, etc. The results are listed in Table III. and some typical curves noted by a star are also shown in Plate I.

Discussion of Results.

Allowing for individual variations in the test specimens, these results are in fairly good agreement with those given before. The proportional limits are nearly all lower than in the other series, but most of these specimens were of somewhat softer material, as shown by the tensile strengths. The elastic limits check those in the first series, and the moduli of elasticity agree with those in the second series, except in the case of the manganese-bronze, where there is a considerable difference, probably due to a different quality of metal.

It seems quite evident from this work that the elastic limits of these cast bronzes are nearly always found lower than the proportional limits, and never higher. The writer does not attempt to explain or defend this statement on theoretical grounds, but the curves certainly seem to demonstrate its truth.

Another point brought out clearly by the curves and tables is that there is no uniform relation between the proportional limit and the yield point or tensile strength in these alloys. Comparing tests 37 and 38, for instance, the latter showed a decidedly higher yield point (and modulus of elasticity) due to separation of the copper-tin eutectoid in greater amount, but its real proportional limit was as low as in the other specimen. Also the zinc-bronzes have distinctly lower yield points and much lower tensile strengths than aluminium-bronze with 1 per cent. iron, yet the proportional limits of these two alloys are practically the same. When heat treated, however, the aluminium-bronzes are far superior to any of the other non-ferrous alloys in elastic properties, and the method of treatment leaves them free from internal stresses so that their proportional limits are very distinct and easily recognised.

No claim can be made for exceptional accuracy in these tests, but it has been demonstrated that a definite proportional limit can be found for non-ferrous castings without any great refinements of testing such as would be impractical in commercial work. When it is not desired to determine the elastic limit or modulus of elasticity, the proportional limit can be found with little trouble by means of a Berry strain gauge attached to the test specimen and used as an extensometer. It is necessary, however, to pull the specimen with spherical-seated holders.

Of course, any of the good extensometers on the market can be used with at least equally good results, and any of the methods for proportional limit determinations that have been described before the Society for Testing Materials may be followed.

It is suggested that for acceptance tests of non-ferrous castings the rough determination of the yield point as the stress giving a deformation of 0.5 per cent. should be discarded as of no real significance, and that the importance of tensile strength measurements for this class of material should also not be emphasised, but that proportional limit determinations should be made and used for acceptance or rejection of bronzes that are intended to resist stresses in service. Ductility as expressed by a good percentage of elongation is probably a necessary quality to guard against brittleness; but as a measure of stiffness and useful strength without distortion, the proportional limit and not the yield point should be employed. That this can be done as readily in non-ferrous work as with steel is the chief conclusion to be drawn from the tests that have been described.

TABLE III.—*Results Using Special Extensometer.*

Test No.	Elastic Limit.	Proportional Limit.	Modulus of Elasticity.	Yield Point.	Tensile Strength.	Elongation, per Cent.	Red. of Area per Cent.
			Zinc-Bronze, Alloy G.				
37	10,500	10,500	11,500,000	17,000	37,300	30.0	26.2
38*	8,500	10,500	13,800,000	22,000	32,900	15.0	20.0
			Zinc-Bronze, Alloy Pc2.				
39	7,500	10,000	11,500,000	17,600	35,700	27.0	33.2
40*	9,000	10,500	13,500,000	17,900	35,800	24.0	30.2
			Manganese-Bronze.				
41	13,500	13,500	16,000,000	29,600	77,600	20.5	21.8
42*	12,500	13,500	15,400,000	27,800	73,000	25.5	23.8
			Aluminium-Bronze, 1 per Cent. Fe.				
43*	8,500	11,000	15,500,000	26,600	73,400	20.5	21.6
			Aluminium-Bronze, 1 per Cent. Fe, Heat Treated.				
44*	30,000	34,000	15,000,000	51,600	81,800	9.0	16.5

* These curves shown in Plate I.

SODIUM FLUORIDE AS WOOD PRESERVATIVE.—Tests made years ago at the Forest Products Laboratory indicated that sodium fluoride might be successfully used as a wood preservative because it had high toxicity, was not injurious to metal, and was convenient to handle. Tests extending over 5 years on sap-pine ties used in a mine in Birmingham, Alabama, and on red oak ties in the tracks of the Baltimore and Ohio Railway Company show that ties treated with sodium fluoride remain in as good condition as those treated with zinc chloride, both showing very little deterioration. Ties treated with creosote were in still better condition, while untreated ties were in various advanced stages of decay.

Cupola Designed for Continuous Operations.

A number of new features are incorporated in a new cupola plant which has recently been completed by the Modern Foundry Company, Oakley, Cincinnati. The improvements result in better mixed and cleaner metal, saving of time and effort by reducing to an absolute minimum the practice of "stopping in" so common to most foundries, securing of a continuous run of metal and saving of time and labour on the part of the employés of the plant.

The cupola is raised 10 ft. above the floor to enable a container to be run under it, so that when the bottom is dropped at the end of the day's run all the material in the furnace will drop directly into it. The container is then picked up on a lift truck and immediately taken away. This does away with the labour involved in clearing up the floor after the bottom doors are dropped and permits the empty furnace to cool in a shorter time.

A new method of lifting the bottom doors into place has also been installed and to show the amount of time and labour saved in this one operation, it may be mentioned that one man can now lift the bottom doors into place in about 3 minutes, where formerly five men were required, taking 20 minutes. The method used is a simple one. The bottom doors are equipped with rollers, and an eye bolt is inserted in the furnace hearth plate at one side of the doors. When the doors are to be raised a wire rope is passed over the rollers on the doors, and a hook on one end attached to the eye bolt. The other end is attached to a chain block, located on the compressor floor above, and in this way the doors are simultaneously hoisted into place, only one man being required.

The bottom doors are held in place by a pivot beam, and a prop suspended from the ceiling fits into a slot at the outer end of the beam, thus preventing the movement of the beam when the cupola is running. For safety purposes a 1-in. pin prevents this prop from moving out of its place. When it is desired to drop the bottom doors, an air hoist is used, the hook being attached to the U-bolt in the prop, the safety pin withdrawn and the air turned into the hoist. When the supporting prop is released from its position, the weight of the metal on the cupola bottom is sufficient to swing the pivot beam and thus allow the doors to open. As an additional safety measure when the fur-

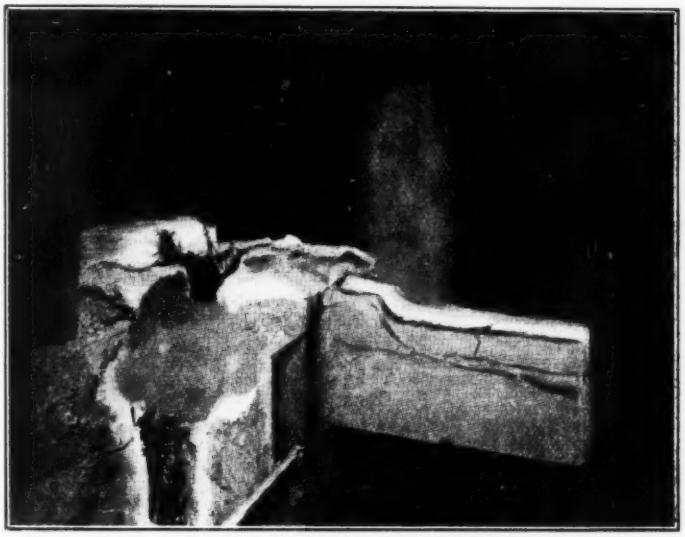

FIG. 1.—VIEW OF SLAGGING SPOUT, SHOWING SLAG NOTCH PARTLY OPEN.

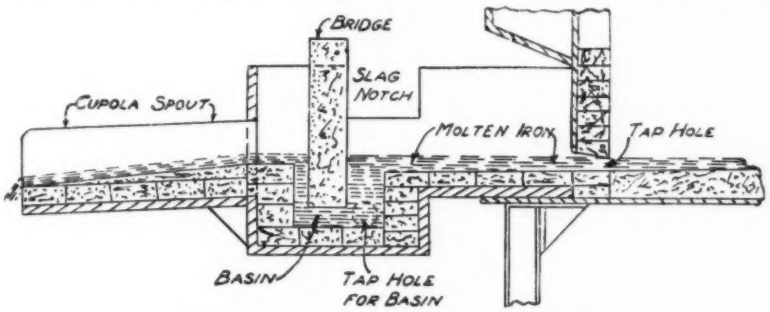

FIG. 2.—SHOWING SECTION OF SLAGGING SPOUT.

* Abstract from Article in Iron Age, Vol. 105, No. 24, June 10, 1920.

nace is running, the hook of the hoist is always disengaged from the supporting prop and the air hose leading to the hoist disconnected. The same workman is always assigned the task of operating the hoist, and in this way the chances of the doors being dropped otherwise than by intention are eliminated.

Another feature of this installation is the methods employed for insuring practically continuous operation, and also the certainty of securing better mixed and cleaner metal. This is accomplished by the slagging spout and the mixing ladle placed in front of the cupola, illustrated in Fig. 1 and shown in section in Fig. 2.

In order to operate the cupola continuously and thoroughly skim the molten metal, a slagging spout is used. When the furnace is tapped, molten metal flows into the basin. When the basin is filled, slag on top of the metal is held back by the bridge, and flows off through the slag notch on the side of the spout. While the furnace is in operation the top of the slag chamber is covered with a flat fire-brick tile. It will be apparent that it is practically impossible for the slag, resting as it does on top of the metal, to pass the bridge, into the mixing ladle. At the end of the heat the metal basin is tapped through a hole in the side and drained off, ready for the next day's work.

The mixing ladle, electrically operated, is placed directly in front of the cupola and is controlled by the operator from the platform above. This ladle has a teapot spout, and the same idea of a brick dam as carried out in the slagging spout is also used here. When the metal is being poured, the ladle usually contains from 4,000 to 5,000 lbs. of iron, and has a capacity of three tons. The use of this ladle insures continuous operation, as it is not necessary to "stop in" when ladles are being changed. It is only necessary that the operator tilt the mixing ladle back and the extra capacity easily takes care of the flow of metal from the cupola. Since the mixing ladle at all times contains molten metal equivalent to one complete charge, the proper chemical mixture is assured in the foundry ladles.

The cupola was built by the J. W. Paxson Company, Philadelphia, and was erected under the supervision of A. N. Kelley, superintendent of the Modern Foundry, who is responsible for the installation. So efficient has this installation proved that the other cupola is now being similarly equipped.

Recent Developments of the Electric Furnace in Great Britain.*

By D. F. Campbell, M.A., A.R.S.M.

In no branch of metallurgy has greater advance been made during the war than in the development and use of alloys, such as those of nickel, chromium, molybdenum, or manganese, and the electric furnace has been responsible in most cases for both the reduction of these refractory metals from their ores and the subsequent manufacture of the alloy steels for these special purposes. Newcastle has been the principal centre for the reduction of chromium, tungsten, and molybdenum ores, and at the time of the Armistice works were in regular operation of sufficient capacity to produce Britain's war requirements of these essential metals.

In 1914 the quantity of energy used on electric furnaces in Britain, excluding those used for aluminium, was probably less than 6,000 h.p., but on the day of the Armistice the total capacity was in excess of 150,000 h.p., of which 135,000 h.p. was producing steel, and 18,000 h.p. was working on the reduction of chromium and tungsten ores. On the day of the Armistice electric energy was being consumed at the rate of nearly 3,000,000 kw.-hrs. per annum for this purpose alone. The electric steel production had then reached a total of over 200,000 tons per annum.

The tendency in electric-furnace design is rather to increase the power of transformers on furnaces of moderate capacity than to build large furnaces. One limiting factor is the size of electrodes that can be conveniently employed, but if there be any demand for larger furnaces, there is no objection to the use of six or more electrodes. If large tonnages of electrically-refined steel are wanted, it is customary to refine steel previously melted and treated by the Bessemer or Thomas process, and in that case the electric furnace need never be of more than 25 tons capacity, which is the largest vessel used for these processes.

There are technical disadvantages in electric furnaces of more than 25 tons or more than 3,000 kw. capacity, and there is no advantage in using the furnaces of 6,000-7,000 kw. which have been recommended abroad for making alloys and carbide. In most furnaces of the arc type, regulation of load is effected by variation of the arc gap, either by hand or automatic regulation. The latter system has probably been more highly developed in this than in any other country, owing to the high cost of power, and the system by which individual furnaces are kept at any desired contant load by Thury automatic regulators is widely applied. The regulation also materially assists in keeping both the composition of the bath and temperature of the furnace within desired limits. In addition, the regulation of a battery of furnaces by a master instrument is of especial interest to power producers and those who pay for energy on a maximum-demand basis. An instrument is finding application which will keep the total load of a battery of furnaces within desired limits by slightly reducing the load on the furnaces if the demand at any time exceeds the total load which the station engineer or the power contract may set as maximum total load to be utilised. Individual furnaces can be removed from the influence of the master regulator by drawing a switch, but the energy absorbed by that furnace is always included in the total power which the regulator will allow the furnaces to absorb.

There are great advantages in establishing certain electro-metallurgical processes in England, in spite of the lack of water power, for this country is so highly favoured with the other essentials for successful industry that the supposed advantages of cheap hydro-electric energy are counterbalanced in the case of many processes in which skill and cheap raw materials are important factors; consequently power economically generated from steam and efficiently distributed may form the basis of many electro-chemical industries.

The production of aluminium, ferro-silicon, and carbide are industries for which water power is usually essential, but in steel-making the quantity of energy used is comparatively small, and the skill and special plant required for its treatment are so great, that the local advantages of England outweigh the advantages of low-power cost abroad. Processes such as steel-making that only use about 40 per cent. load factor, *i.e.*, four-tenths of the possible output of the plant reserved for their use, are more suitable for steam stations, which have low capital expenditure and high running costs, rather than hydro-electric stations, which involve the outlay of large sums for capital account, but small operating expenses.

The next immediate development will probably be the general application of electric smelting to the treatment of complex zinc ores and the gradual improvement of existing processes in the development of power and utilisation of the fuel we now waste. Further, the phenomenal growth in the world's consumption of aluminium and the great possibilities of its alloys offer a fruitful field for investigation and industrial enterprise. Indeed, electro-metallurgy, though still in its infancy, is making rapid progress.

* Abstract of a Paper read recently before the Annual Meeting of the Society of Chemical Industry.

Pressed-Steel Flasks, Core Plates and Bottom Boards.

A line of pressed steel foundry equipment, including flasks, core plates and bottom boards, has recently been placed on the market by the United Metal Mfg. Co., Canton, Ohio. These are made of copper-bearing steel, having rust-resisting and non-corrosive qualities. The flasks are pressed from 7 gauge or a 3/16-in. plate, and are strengthened with corrugations or flutes ¾ in. deep and 2½ to 4 in. apart, depending on the size. It is stated that these corrugations are not of sufficient depth to interfere with the shaking out of the sand. Additional strength is secured by providing a flange at the top and bottom of the flask, the top flange turning outward and that at the bottom turning inward and acting as a support for sand when the flask is raised. The flask is formed in two sections, which are welded together. If the mould requires a three-part flask, a cheek provided with the proper fittings may be used. The surfaces are ground on a surface grinder, this being the only machine operation required.

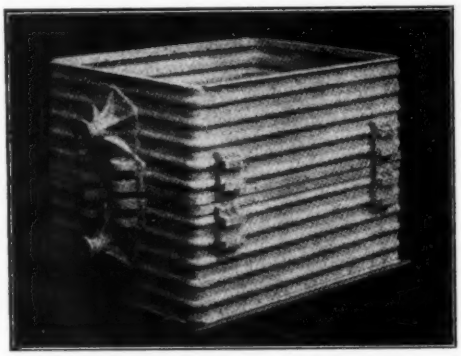

FIG. 1.—PRESSED-STEEL FLASK.

The flask is provided with malleable iron or pressed steel fittings, handles, pin lugs, trunnions, etc., the fittings being rivetted to the flask. Among the advantages claimed for the flasks is their strength in proportion to their weight and the limited amount of machine work required. It is pointed out that owing to their lightness the flasks can be stacked up at a considerable height on a foundry floor or a height that would not be practicable to stack iron flasks because of their heavier weight. The flasks are made in all sizes and heights.

The core plates are made of stretcher-levelled sheets to provide a smooth level surface and to insure against warping, and in various types of construction, depending on the sizes. The very small sizes are plain, flat plates. Larger sizes have edges flanged lengthwise, to give the plates strength and to ensure against warping and twisting. The flanged plates are made either without reinforcement, except the flanged edges, or are further reinforced with two or three cross angles or with two cross angles and one diagonal angle according to size. All sizes are made either plain or perforated.

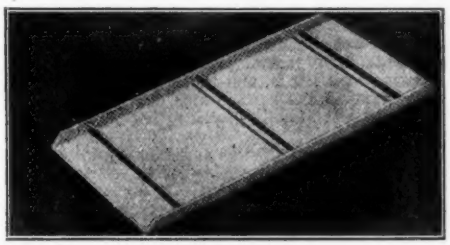

FIG. 2.—PRESSED-STEEL CORE PLATE.

The bottom boards have corrugations which not only add to strength, but provide vents for the escape of gases. The lengthwise edges are turned under to provide additional strength and a clamping edge ½ in. in thickness. This edge tapers inwardly so that clamps will draw together rather than snap off. Each board is provided on the under side with V-shaped cross reinforcements and four steel feet to allow it to stand in the floor sand without rocking and to provide ample clamping and lifting clearance between board and floor.

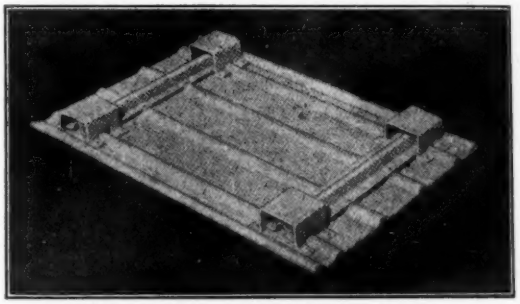

FIG. 3.—PRESSED-STEEL BOTTOM BOARD.

Advantages claimed for the steel bottom boards are that they will not burn or deteriorate as quickly as wood, are lighter in weight and easier handled than cast iron, and there is no danger of breakage due to rough handling.

THOMAS L. HALE, LIMITED, have now removed from their Walsall works to a new and commodious foundry at Dudley Port, Tipton.

The Future Status of the Foundryman.

By F. R. Parsons.

The present is not an inopportune time to review the existing conditions, moral, social and otherwise, of the foundryman, and to try, if this be possible, to forecast his future.

In the first place, it must be said that the present writer is not a member of the "sand rat" fraternity, although not far removed therefrom, being one of those to whom the finished product of the foundry is raw material. Nevertheless, the views he is about to express arise out of a long and intimate association with the industry of iron founding, and a close observance of the general conditions met with in the trade.

It has been said by some who surely ought to know better—chapter and verse could be quoted to prove this—that the day of the iron foundryman is fast on the wane, that his period of usefulness in the engineering arts has reached its zenith, that there is to-day much less need, in a general manufacturing sense, for the products of his hands, and that in the not very distant future stamped and pressed steel and steel plate work will have almost wholly displaced the necessity for iron castings.

This is entirely wrong, and the opposite view is more correct, that with the approach of wider developments in the various branches of engineering science, the application of higher steam pressures—for the trend of present-day development lies in this direction—the increasing application of mechanical means in the displacement of hand methods and processes, the world-wide desire to raise the maximum product of a horse-power hour rendered necessitous as a compensatory measure by the reduced application of the human element, the very many entirely new phases of industry which, when the world has quite recovered from the shock of war, will present themselves for elucidation, will make such a realisation wildly impossible.

Is it conceivable that such mechanical development could possibly be directed along channels wherein cast iron finds no component part? We need not waste time in pursuing this point further; the argument is irrefutably against such an unlikely happening.

What we are far more concerned about at the moment is the status of the iron foundryman. Were labour troubles a factor existing only in imagination, and not in reality, what should we find in the foundries to-day? Would it not be a very serious shortage of workers? Is it not fact that were the engineering trades a contented, homogeneous, amenably disciplined, serious-minded organisation, anxious and eager to accelerate output, to make up lost leeway, to settle down to their labours with a kindlier spirit towards themselves and their employers—would it not be found that there would be a larger volume of work to be done than there are workers to do it? And this applies not only in a general way to the engineering trades, but more particularly to ironfounders. There would be a distinct dearth of those skilled operators to whom we should have to look for the production of iron foundry material.

Now why should this be? Let us leave out the war and its consequences as contributory factors to this state of things, because while it will pretty generally be agreed that the war's upheaval has in every sense been a contributory factor, perhaps a hastening of the inevitable, such a state of things were beginning to reach its present climax even before the outbreak. This was only too obvious to anyone directly in touch with, or allied to such industry.

At the best work in an iron foundry is diabolically hard, it is a filthily dirty occupation, and in many cases, notably in small repetitive plates and machine work, it is intolerably monotonous. To youth it must be wholly unappealing except to the lower class boy who can appreciate nothing of an æsthetic character, and to whom the drab drudgery and the damp, clammy black sand, the air surcharged with coal dust and plumbago cannot rob a tittle of his fine perceptions.

Utterly as I might have condemned the profession of iron moulding, I am, however, quite as ready to admit that its unattractive features, which it is clearly recognised are responsible for the existing difficulty in getting good class boys to enter a foundry, are too often aggravated by the men themselves. It has been demonstrated time and again that where an employer has made a special effort—one such case in mind is that wherein an employer spent several thousand pounds in providing a wash-up, dining and reading rooms—in attempting to raise social and moral standards, the men concerned will invariably refuse to be thus uplifted, preferring by far to pig out their meal hours in some filthy hole or corner of the foundry.

But, on the other hand, the employer himself cannot be held immune from blame. Unless he rids himself of the all too prevalent idea that any odd corner is good enough for a foundry, and that it must of very necessity be a filthy, disordered, unwholesome area, then will its inhabitants partake of the same nature, and the employer must not expect to attract other than the lower class boy. Let him lay out his foundry on hygienic, scientific principles, insisting upon order and, as far as possible, upon cleanliness. Let him make it an inviolable rule of the shop that habits of personal cleanliness must at meals and leaving-off times be rigidly observed; such insistence being as much his duty to assist by every means practicable and possible as theirs to conform. Let him also reintroduce the old apprenticeship system, under which the boy would have every right to expect and receive a conscientious training in all branches of foundry work, together with the provision of some means for giving him such theoretical training as is necessary. Thus would the status of the trade be upraised.

In connection with the training of foundry apprentices it is important to remember that for several years before the war efforts were made especially in London, to induce technical institutes to form classes for foundry practice, but owing to the difficulty in obtaining sufficiently interested lads failure dogged every attempt.

The Apprenticeship Training Committee of the old Foundrymen's Association also sent out some 35 letters to different technical institutes in and around London, asking them to take up the training of foundry boys. Only three replied!

It is only through education, social and technical, that we can hope to improve the status of the coming generation of foundrymen. Also there must be inculcated a higher and a better appreciation of the importance of the trade in relation to the industries of the country; this, and a higher educational standard. High wages will not effect this so surely as will the establishment of better working conditions, and the scrapping of everything that tends to lower the dignity and manliness of the iron moulder.

STEEL JACKETS AND BANDS FOR USE WITH SNAP FLASKS.—A useful steel jacket and band for use with snap flasks are manufactured by the Adams Company, Dubuque, Iowa. After the flask is removed, the jacket, or stripper, is shoved down over the mould to prevent its bursting while being poured. No. 10 gauge steel is used in constructing the jacket. The corners are reinforced with angle irons which are electrically spot welded, as are the angle irons on the ends, and the channel iron on the sides. The jackets are made to any size desired, either straight or tapered. The accuracy with which they are made, it is explained, assures even pressure on all sides of the mould, thus to minimise run-out troubles and reduce moulding costs. The bands are of No. 10 gauge steel, spot welded, and are to be slipped inside of the snap flask before the mould is made, and in either cope or drag depending upon which part of the mould is likely to burst out. The bands are 3-16 in. smaller in length and width than the inside of the flask.

Moulding Hand Rope Wheels, with Wrought Iron Spokes.

A. B. Smith.

The following article describes the methods adopted in overcoming some of the difficulties experienced by founders in this class of work. Hand rope wheels of

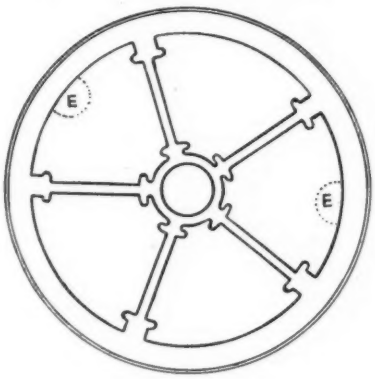

Fig. 1.

the type illustrated are extensively used in lifts and hoists, and many foundries engaged on these articles still adhere to the method of bedding in the floor, using

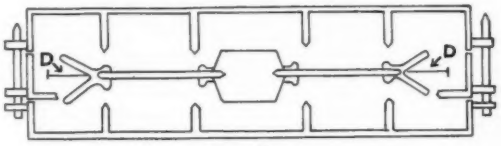

Fig. 3.

a loose ring for the middle. This method, although satisfactory where only a small number of castings are required, involves a large amount of unnecessary labour

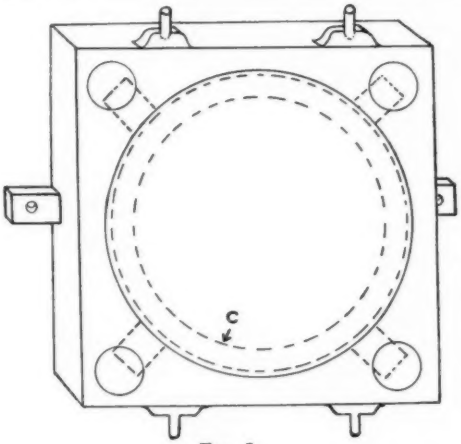

Fig. 5.

and time, and in foundries having running orders for this class of work the following method, which would result in a considerable saving of labour and increase in output, could be adopted. The tackle used can be utilised for other work, a fact which can be set off against the initial outlay. The wheels are generally made in sizes varying from 1 ft. 6 in. to 4 ft. diam., increasing in steps of 3 in. diam. for various speed and load requirements. It is therefore advisable to have boxes that will take alternate sizes, say three sizes per box, by using detachable rings in middle frame. The pattern is of course split, as shown in Figs. 1 and 2. The box is of ordinary design, square, top and

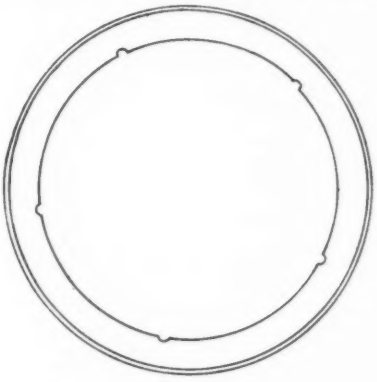

Fig. 2.

bottom accurately matched so that they may be used for other work when desired. The middle box or frame, as in Fig. 6, is cast with hollow centre, this centre being large enough to take the largest size of any three wheels. The same box can then be used for any lesser size by putting in a ring, as at Fig. 6. This ring

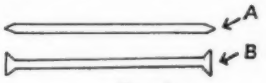

Fig. 4.

can be cast open sand with four lugs attached, by which it is carried in centre box, as shown by the dotted lines in Fig. 5. This renders unnecessary a complete middle to fit each wheel. The width of the ring is determined by the difference in diam. of the wheel and circle in middle box.

Many founders experience a great deal of trouble in the unequal contraction set up when casting in wrought-iron spokes. The system in vogue, which is highly successful, is largely due to the method of preparing

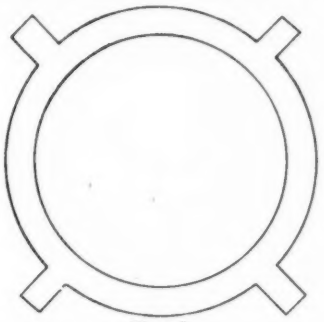

Fig. 6.

the spokes. Many people still utilise the method of up-setting the ends of the spokes, as at Fig. 4B. The best method is to grind the ends taper, as at Fig. 4A. This is a very important point, and is explained as

follows:—As the wheel is two separate castings, the boss and the rim, the liquid contraction takes opposite directions. The boss to its own centre and the rim to its own centre, thus when cast one pulls directly away from the other, the jagged ends of the spokes setting up great resistance and nine times out of ten the wheel flies. If the spokes are tapered the metal in contracting actually slips away. During the writer's experience, as many as 70 wheels have been cast without a waster, and it is very rare that one finds a spoke loose.

MOULDING.

When making a quantity a plaster of paris odd side is used to form the bottom mould. The bottom half pattern, Fig. 1, is placed on the odd side. The bottom box or drag is next placed in position and cramped to the odd side, the box being rammed up and turned over on to a bed. The odd side is next removed, and the middle box is placed in position on the drag. A layer of sand is placed all round the rim up to the centre and rammed, care being taken not to go above the centre. Next a layer of sprigs is laid all round the rim within a ¼ in. of the pattern, as at D, Fig. 3. The top rim, Fig. 2, is placed on the pattern, the ramming being now brought up to the edge, that is, to the top edge of middle box. The joint can now be made, after which the top box is placed in position. This may now be rammed, runners being placed one on the boss and two on the rim opposite each other, as at E, Fig. 1. The top may now be lifted off and the top rim of the wheel may be removed. The bottom pattern should be loosened, when the middle box can be lifted off. This should not need to be turned over. The bottom pattern can now be removed and the middle box replaced in position.

The iron spokes are next put in position. These should be painted with red lead on the ends to be cast in. The top box being put back, the whole can be cramped and bushed ready for casting. In casting it is usual to cast the rim first, leaving about two hours or the run of a blow for cooling before casting the boss. By adopting this method it is found the results are more satisfactory. Owing to the lightness of the design of these wheels, it is necessary to use a good, soft iron. Some firms advocate coring the rim to further lessen the cost of equipment and time in moulding. This method is not satisfactory owing to the joints of the cores leaving a rough joint on the casting, which tends to wear and cut the ropes. A moulded rim is preferred, as it produces a much cleaner and smoother groove.

TIN IN SOUTH CHINA.—The tin supply of South China will soon go out of the markets of the world unless there is a rapid and complete change in the situation. Chinese tin is produced on the basis of a silver dollar whose exchange value is substantially that of $1 gold, while Straits Settlements tin, the chief competitor of Chinese tin in the markets of the world, is produced on the basis of a Straits dollar worth about 56 cents gold.

ALUMINIUM ALLOY BELL-METAL.—In a recent issue of "La Fonderie Moderne," a new type of bell-metal, consisting of an aluminium alloy, was described by G. Péricaud, the patentee, for the manufacture of all kinds of small bells, such as telephone, sleigh, and other bells cast, pressed or made by any other process. The composition of the alloy is given as follows:—Aluminium 88 per cent., copper 4 per cent., and tin 8 per cent These properties may be varied within 2 per cent

MESSRS. MURRAY COOMBS AND RICHARDS, Cross Keys House, 56, Moorgate Street, London, E.C.2, who have been appointed representatives for the United Kingdom and Europe of W. G. Watson & Company, Limited, Sydney, Australia, are removing to Premier House, 150, Southampton Row, W.C.

American Society of Mechanical Engineers' Symposium on Castings.*

Six papers designed to assist the mechanical engineer in intelligently specifying the proper kind of casting for a given piece of construction were recently presented and discussed at the foundry session of the American Society of Mechanical Engineers, presided over by F. O. Wells, formerly president Greenfield Tap and Die Corporation, Greenfield, Mass. The aim of each paper was to outline the special properties of a particular kind of casting, and where it is to be preferred to other forms of cast metal.

Dr. Richard Moldenke, Watchung, N.J., presented a discussion on grey iron castings. After touching on the carbon situation in cast iron, he dealt briefly with its chemical composition, giving in this connection a table of recommended compositions for many varied purposes. He called attention to the extent to which specialisation has taken place in iron founding, and enumerated the various classes of foundries and the lines of work to which they are best adapted. He urged that mechanical engineers let their work to foundries best fitted by their experience to handle it. In England and America, he said, strength in castings is given less attention than machineability, while the reverse is true in continental Europe. There the technical staffs of all foundries, from manager down to assistants in the several production and testing departments are all graduate engineers. The consequence is that castings are made strictly for the purpose intended, and not merely to get by the machine shop, as is unfortunately so often the case here.

Results of Excessive Use of Scrap during War.

One of the by-products of the war, said Dr. Moldenke, was the excessive use of scrap by foundries; in some cases as high as 90 per cent. to 10 per cent. of pig-iron. Within the next 20 years, he predicts, these castings running high in sulphur content will return to the melters in the form of scrap. The problem which will confront the foundries may be solved either by using more pig-iron in mixtures or by employing a desulphurising process. Until very recently, no method of removing sulphur was available, but of late the electric furnace has been employed for this work with complete satisfaction. The molten metal is transferred from the cupola to an electric furnace with a basic lining. As the metal comes to the furnace hot, the extra cost of desulphurisation is not great. The castings made are much better and sounder than the ordinary run, equalling charcoal iron castings made in the air furnace.

Permanent Versus Long-life Moulds.

The subject of permanent moulds was brought up in the discussion of a paper on malleable castings by Prof. Enrique Touceda, Albany, N.Y., which was read by Prof. Arthur M. Greene, Renoselaer Polytechnic Institute, Troy, N.Y. Dr. Moldenke stated that he invariably found that castings made in iron moulds were not as strong as those made in sand moulds. In iron moulds, he said, the metal is chilled so quickly that internal strains are set up. Permanent moulds are not only unsatisfactory, but very expensive. Research work, he believed, should be in the direction of long-life moulds rather than permanent moulds. He cited work which had been done with moulds lined with gas carbon mixed with pitch—a very refractory material. Fire brick has also been used successfully for parts of moulds.

Malleable-Iron Castings and the War.

Capt. J. E. Hughes, Ordnance Department, U.S. Army, took exception to a statement in Prof.

* Abstracted from Iron Age.

Touceda's paper to the effect that malleable castings were not used as extensively for war purposes as they should have been, because Army officers were not familiar with their physical characteristics. Captain Hughes recited difficulties encountered in securing satisfactory malleable castings for various purposes, and charged the malleable iron foundries with not doing the research work necessary to develop their product for Army needs. Malleable castings for drop bombs, for instance, were found so porous that they would not withstand hydrostatic tests.

Dr. Moldenke suggested that perhaps Army specifications were too high, but agreed that porosity was characteristic of malleable castings. The latter, he said, are essentially white iron castings, the contraction of which runs as high as 12 per cent., resulting in an open structure on the inside with a series of planes of separation and generally a shrink spot in the centre. He pointed out, however, that there is nothing better than a malleable casting under shock because of the cushioning effect of the amorphous carbon.

Cast Steel Unsuited for Wearing Surfaces.

The subject of steel castings was covered in a paper by John H. Hall, Taylor-Wharton Iron and Steel Company, High Bridge, N.J., which was read by Prof. H. Wade Hibbard, University of Missouri. Mr. Hall dealt briefly with the physical properties of steel castings and their improvement through annealing and heat treatment, cost of castings and the classes of work for which steel castings should be specified. Castings are now made, the paper stated, with physical properties nearly twice as good as those of the ordinary commercial product, and where the service demands unusual strength, toughness and resistance to wear and fatigue, their use is urged even though they machine less freely. In discussing the extent to which cast steel has taken the place of forged steel, Dr. Hibbard stated that for wearing or rubbing surfaces cast material would not stand up because of its crystalline structure.

The trip made by Convention visitors to the plant of the Commonwealth Steel Company was referred to in the discussion, particular interest having been aroused by that company's method of moulding tender and car frames as long as 45 ft. These double-body bolster castings were formerly made in green-sand moulds, but the difficulty in obtaining uniformity in weight and size and the frequency of scabby and imperfect castings resulted in the development of the present practice. A cast-iron moulding form is used, having a bottom and four practically vertical sides, into which are built baked sand cores of proper size and shape so that when laid together like brick they form the cavities for a properly shaped mould. The mould is really constructed of both inside and outside cores, with cover cores secured to the moulding form by means of clamps. The mould has 16 shrinkage risers and one pouring gate. To insure the fluidity of the steel, aluminium medicine is added to the ladle and only the hotter portion of the contents is used, the colder metal being utilised for smaller castings. To prevent distortion in shrinkage, the casting is removed from the mould before it has entirely cooled.

Die Castings.

Whereas the permanent mould is not adapted to iron or steel castings, the die casting industry started with a permanent mould and found alloys suitable for its successful use, said Charles Pack, Doehler Die Casting Company, Brooklyn, in presenting his paper on die castings. Die casting, however, entails forcing metal into a mould under pressure as distinguished from castings produced by merely pouring into permanent moulds. The die casting process is best adapted to alloys of comparatively low fusing points, such as those of zinc, tin, lead and aluminium. While he stated that no general rules can be laid down governing the design and application of die castings, he nevertheless outlined general properties of the various alloys used and their fields of application, and gave particulars regarding such limitations as maximum weight of castings, minimum wall thickness, minimum number of threads and minimum diameter of holes that can be cast. The first commercial aluminium die castings, he stated, appeared on the market in 1914, and during the war a suitable steel was developed for making the dies for this process that would withstand the action of the molten aluminium without cracking. At the cessation of hostilities 1,000,000 aluminium die castings were being produced daily in this country for parts of gas masks, machine-guns, aeroplanes, motor trucks, motor ambulances, surgical instruments, canteens, field binoculars, and many other appliances of war.

Mr. Pack also presented a Paper on aluminium castings in the absence of the author, Zay Jeffries, Aluminium Castings Company, Cleveland. A Paper by C. H. Bierbaum, Buffalo, who was also absent, was presented. Following a short discussion regarding the terminology employed in designating alloys of copper, tin, zinc, and lead, the author cites certain precautions which an engineer should take when specifying an alloy for a given service, and then deals briefly with the various de-oxidisers and fluxes used in the brass foundry. A large part of the paper is devoted to an enumeration of the more important bronzes and copper alloys, their compositions, properties and uses being set forth in considerable detail.

Gas-Heated Crucible and Oven-Furnaces.

By Arthur Forshaw, M.Sc.*

The subject of gas-heated furnaces is a big one, and the advance in our knowledge of it has been very rapid during the last five years. As a result, a good many papers have been published during that period containing a great deal of valuable and interesting information. In the present paper the author gives a general survey of the various types of crucible and oven furnaces in use, and indicates the reasons for adopting one or other of the different methods of heating them, and also enumerates some of the methods of manipulation and the various precautions necessary to ensure not only successful operation, but, what is more difficult, successful operation under commercial conditions in competition with alternative methods of heating.

Crucible Furnaces.—As the result of the opportunities offered during the last few years, great strides have been made in the commercial melting of metals by gas. A consideration of the following points will indicate the reasons for the advance.

Linings.—The first and most essential condition for success is the dimensions of the lining to suit the crucible. The lining must be shaped so that towards the bottom of the furnace, where the flame enters, there is the correct space between the brickwork and the pot stand to allow the proper development of combustion. Higher up, the distance between brick and pot must be reduced to the least that will carry the products of combustion away without causing undue back pressure. This is necessary in order that the hot gases may give up as much as possible of their sensible heat to the pot and the lining by contact; the transference is also assisted by the velocity with which they impinge on the surfaces. In practice, it it found that, with furnaces from which the crucible has to be removed for pouring, this distance is determined by the space necessary to introduce the tongs. In tilting furnaces, however, the distance may be made exactly as desired. The greater the distance

* Abstract of Paper read before the Birmingham Metallurgical Society, May 6th, 1920.

above the correct one, the higher will be the gas consumption per lb. of metal melted.

Crucibles.—As in the case of linings, adequate attention to detail is amply repaid in the balance sheet. First of all, new pots should not be put into work without previous annealing. The object of this is to free the material of the pot from all moisture, and in the absence of special apparatus for the purpose it may well be achieved by storing the pots on the top of annealing ovens or in core ovens, either of which are usually to be found in a works where metal melting is carried on.

Provided the pot survives the first heat its life will mostly depend on the correct setting of the gas and air to one another, and as the correct setting for economical melting coincides with that for the longest life of the pot, this is a point to which attention must be given.

One other cause of short pot life should be mentioned, viz., corrosion by fluxes. This occurs in a ring all round the inside of the pot at the level of the metal, and while the rest of the pot may be perfect it has to be discarded on this account. As to what this life should be it is again, as in the case of furnace lining, difficult to say definitely. It may be stated that small crucibles melting the same metal last longer than large ones, and crucibles that are not handled, as in tilting furnaces, longer than those in pit furnaces where they are removed by tongs before pouring the metal. Figures already published show the following results :—

Consumption of Gas.—So far no mention has been made of the consumption of gas that may be reasonably expected in melting metals, and this is the item in melting costs that can be most conveniently watched and checked. The first question always asked when the use of gas furnaces is under discussion is "How much gas do they burn?" For this reason it generally assumes too great a prominence in the mind of the inquirer, and the other important items of life of linings and crucibles, saving of space and labour and capital outlay and so on, are apt to be given too secondary a consideration.

Now that so much melting has been done in foundries, results are beginning to be published from actual practice, and the following table is a collection from various sources, all the figures being taken in foundries and not in furnace manufacturers' laboratories.

TABLE I.

Metal.	Crucible size.	Life in heats.	Life in coke furnace.
*Brass 60/40 ..	60 Pit ..	80—90	30—40
*Cupro-Nickel 80/20	250 P. ..	14	5—6
† ,, 80/20	60 P. ..	17.6	12—5
*Aluminium ..	600 Tilter (140 lbs. Al)	150	
*Brass	300 lbs. T.	100	

* Forshaw "Gas Furnaces, their design and manipulation," Ga Journal CXL. (*November 13th*, 1917).

†Brook "Coal Gas as a fuel for melting non-ferrous alloys." Inst. Metals (*March* 22nd, 1917).

TABLE II.

Metal.	Crucible size or wt. of charge.	Pouring temperature.	No. of melts.	Cub. ft. per lb.	B. Th. U. nett per lb.	Average time per melt.	P.—Pit type T.—Tilting
Air blast 3 lbs. per square inch, with Preheater for metal.							
Brass 60/40	60 P.		71	2.40	1200	25 nett	
Gunmetal 88/10/2 ..	100 P.		14	3.37	1720	39 ,,	Forshaw loc cit
Brass 70/30	300 T.		31	3.54	—	50 ,,	
Cupro-Nickel 80/20 ..	60 P.	1370	96	8.50	†4080	52 ,,	Brook loc cit
Air Blast 2½ lbs. per square inch, with extension sleeve to crucible but no Preheater.							
Gold 91.7/8.3 Cu. ..	191½ P.	1150	*Comparatively short runs during 5 years working.	3.12	1592	105 gross	Hocking loc cit
Silver 92.5/7.5 Cu. ..	411½ P.	1090		5.35	2729	†172 gross	
Bronze 95/4/1/Zn. ..	400½ P.	1165		6.47	3300	160 gross	
Cupro-Nickel 75/25 ..	400½ P.	1300		9.82	5008	228 gross	
High Pressure Gas, 12 lbs. per square inch, apparently without Preheater.							
Brass 60/40	60 P.		75	‡7.6	3800		Walter loc cit
,, 72/28	160 P.		75	‡ 6.2	3100	190 gross	
,, 60/40	160 P.		year's working.	5.9	2950		
Cupro-Nickel 80/20 ..	130 P.		13	9.4	4700	96 nett	

* The total quantity of metal melted in 5 years was 10,146 tons at an average of 5.32 cu. ft. or 2715 B.Th.U. per lb., assuming 510 B.Th.U. nett per cu. ft. For coke melting 4954 tons required 54 lbs. coke or 6480 B.Th.U. per lb. (assuming cal. val. of 12,000 B.Th.U. per lb. nett).

† Calculated from data in the original Paper.

‡ After 12 months' use Walter remarks that by using the Furnaces at full capacity this figure on another test was reduced to 4.5 cu. ft. or 2,250 B.Th.U. per lb.

ACETYLENE FOR AUTOMOBILES. — The "Technical Review" describes investigations recently made in Switzerland on the use of acetylene as a motive power for automobiles. Two-stroke, four-stroke and Diesel engines were used, with a mixing valve which allows for the variation of the amount of air to be added to the gas. Comparisons of a motor using gasoline and acetylene are given. With acetylene the motor is less liable to overheat, and the cylinders and valves keep unusually clean. Oil consumption is heavy when pure acetylene gas is used, but if a small amount of warm water is drawn into the cylinders in the form of a spray, the consumption is less than with gasoline.

Trade Talk.

MESSRS. VITORIA, GALBETE & COMPANY, agents for Spanish iron-ore shippers, have removed to 32, Fenchurch Street, London, E.C.3.

J. C. HILL & COMPANY, LIMITED, steel wire and nail manufacturers, propose to deal with all correspondence from 20, Copthall Avenue, London, E.C.2.

LEWIS & TYLOR, LIMITED, makers of the Gripoly belting, announce the removal of their London offices from 51, Gracechurch Street, E.C.3, to 9, St. Thomas's Street, S.E.1.

THE WILSON-WOLF ENGINEERING COMPANY, LIMITED, Bradford, have appointed Messrs. Pooley & Austin, 34, Broadway, Westminster, S.W.1, as their sole agents for London and district.

J. CHADWICK & COMPANY (LEEDS), LIMITED, brass founders and finishers, Dewsbury Road, Leeds, have purchased a site for the erection of a new works in Jack Lane, Hunslet, Leeds.

THOMAS ROBINSON & SON, LIMITED, engineers, Rochdale, have invited subscriptions for an issue at par of 125,000 7½ per cent. cumulative preference and 25,000 ordinary shares, all of £1 each.

SIR JOHN R. WRIGHT, chairman of Baldwins, Limited, has issued a denial that his directors have accepted the terms of Messrs. Sperling & Company to purchase the ordinary shares of the company.

GUEST, KEEN & NETTLEFOLDS, LIMITED, have purchased from the Tredegar Estate the freehold of their Castle Works at Rogerstone, amounting to about 50 acres, with an additional area of about 100 acres.

THE shareholders of Brunner, Mond & Company, Ltd., have sanctioned the suggestion of the directors that they should distribute £100,000 to universities or other scientific institutions in the United Kingdom for the furtherance of scientific education and research.

THE WELSH TINPLATE & METAL STAMPING COMPANY, LIMITED, have acquired the Patent Slip, which is situated near the Llanelly, Carmarthenshire, Dock. Nothing has yet transpired as to the use to be made of this site, but the works of the company adjoin the slip.

THE GLASGOW CORPORATION TRAMWAYS COMMITTEE have reaffirmed their decision to place an order for 10,000 tons of steel rails with an American firm. The sum involved amounts to £250,000, and the American tender was some £30,000 less than an offer received from a British firm.

IT is reported that John Musgrave and Sons, engineers, Globe Ironworks, Bolton, have received an offer for the share capital, and that at a general meeting of shareholders it was decided to accept the offer. The names of the principals are not disclosed, but it is understood that the majority of the directors of the new company will be local men.

HARLAND & WOLFF, LIMITED, propose erecting repairing shops in various London docks, and are negotiating with the Port of London Authority for the whole of the latter's repairing work. It is understood that if the scheme is completed the management of the repairing shops now owned by the Port of London Authority will be taken over by the firm.

THE SHIPPING CONTROLLER announces that the difficulties which arose recently in connection with the sale of the National Shipyard at Chepstow have now been satisfactorily adjusted with the purchasers, who have withdrawn their demand for a rescission of the contract and have intimated their intention of abandoning the legal proceedings of which they had given notice.

THE GLACIER ANTI-FRICTION METAL COMPANY, LIMITED, of Waldo Road, Willesden Junction, N.W.10, have found it advisable to increase their capital and reconstruct the company under the title of the Glacier Metal Company, Limited. There will be no change whatever in management or policy, and the business will be carried on at the same address exactly as in the past.

PLANS for an aggressive campaign for new members have been formulated by the 1920 Promotion and Membership Committee of the American Foundrymen's Association. The campaign will be handled from the Association headquarters office, in Chicago, and covers three months, culminating in a special "Foundrymen's Week" during September and the annual convention in Columbus, Ohio, the week of October 4.

THOS. C. FAWCETT, LIMITED, are building a new shop at their Whitehouse Engineering Works, Hunslet Road, Leeds, which in the main will be given over to the building of lead sheet rolling mills, hydraulic presses, mixers and other specialities for the lead-working industry. It will afford a much-needed relief in the main works to cope with the increased demand for ore briquetting machinery and auxiliaries in connection therewith.

PARTICULARS have recently been issued of the offer by Vickers, Limited, of £1,500,000 7 per cent. seven-year notes to bearers at the price of 95 per cent. The notes are repayable at par on July 1, 1927. The company reserves the right to issue £2,500,000 further of similar notes. The company may redeem the issue at any time, wholly or in part, on three months' notice. The proceeds of the issue will be used for the extension of the company's business and its large electrical interests.

THE works of the Union Steel Corporation (of South Africa), Ltd., Vereeniging, continue to be fully employed, and have large unexecuted orders on hand. Under an agreement entered into in 1911 the Corporation have still the right to supply 100 per cent. of the Union Government requirements during the next eight years, and this fact was confirmed by General Smuts in a recent debate in the House of Assembly. Good progress is being made in negotiations with the view of erecting furnaces at Vereeniging for dealing with native ores.

Engineers of the Vanadium Corporation of America have discovered large ore deposits on the South American properties, which it is estimated at present rate of consumption can supply ore indefinitely. Up to the present time, known ore deposits on the properties were given a life of approximately twenty years at the rate at which ore was being extracted. Merrill G. Baker, vice-president, returned from an inspection of the properties two weeks ago, and at a recent directors' meeting made known to the board the discovery of the new deposits.

THE Brazilian battleship "Sao Paulo" recently arrived at Portsmouth, having been detailed by the Brazilian Government to convey the Belgian Royal family to Brazil. At Portsmouth the "Sao Paulo" will be completely overhauled by Sir W. G. Armstrong, Whitworth & Company, Limited. This warship and her sister ship, the "Minas Geraes," were designed by Sir W. G. Armstrong, Whitworth & Company, Limited, the latter being built at Elswick. The "Sao Paulo" was laid down at Barrow in 1907, and completed in 1910. Both vessels have a length of 543 ft., a beam of 83 ft., a displacement of 19,281 tons, and a speed of nearly 22 knots.

AN arrangement has been arrived at between the firm of Carl Spaeter, A.-G., of Basle, and certain of the leading steel works in France, *i.e.*, Messrs. Schneider & Company, Paris, de Wendel & Company, Sté Ame des Aciéries de Denain & d'Anzin, Compagnie des Forges de Chatillon Commentry & Neuves Maisons, Paris, as regards the exploitation of Austrian magnesite formerly sold under the brand, "C. S. Anchor." The combined sales organisation will be carried on under the title of the Magnesite Company, Limited, with registered offices at 5 Gerbergasse, Basle, for whom Mr. John Le Boutillier, Colonial House, 17, Tooley Street, London, S.E.1, is acting as sole agent in the United Kingdom.

THE output of new vessels in Scottish yards during July was remarkably good considering the holiday period. On the Clyde the output consisted of 22 vessels

of 65,316 tons, which is considerably greater than the amount launched during any of the preceding months of the year, with the exception of April, when there were 85,000 tons of new shipping launched. Last month the output was 18 vessels of 42,249 tons, and for July, 1919, the returns showed a total of 30,592 tons. On the Forth, 4 vessels of 10,520 tons were launched, compared with 2 vessels of 2,757 tons in June. On the Dee the output consisted of 1 vessel of 90 tons. For the seven months the totals were as follows:—Clyde, 125 vessels, 352,262 tons; Forth, 20 vessels, 33,647 tons; Tay, etc., 5 vessels, 10,623 tons; Dee, etc., 27 vessels, 4,532 tons

The McLain-Carter Furnace Company, Goldsmith Building, Milwaukee, Wis., inform us that on June 7 they melted steel in one of their new 10-ton furnaces for the Black Steel & Wire Company, Kansas City, Mo. This furnace is a specially designed McLain-Carter furnace, and while rated as a 10-ton, the maximum capacity is 30,000 lbs., and it is guaranteed to melt five heats per twenty-four hours. This company will produce high-grade wire of every description, wire rope, etc., and the steel melted in the McLain-Carter furnace will be poured into 4-in., 6-in., and 8-in. ingots. It is expected that the 4-in. ingots, after being cast, will be rolled into wire rods with only one heating, and as this has been considered an impossibility heretofore, if they are successful it is quite a step in advance in wire-mill practice.

At a sale of plant and machinery at the National Ordnance Factory (No. 2), Hunslet, Leeds, the total amount realised was between £80,000 and £90,000, some high prices being secured. A nearly new planing machine, 16 ft. by 5 ft. by 5 ft., sold for £1,375; an 18 in. stroke geared slotting machine, £600; a shaping machine, £550; planing machine, £675; high-speed radial drilling machines, £825 and £1,150; three nearly new "C X" model planing machines, 16 ft. by 5 ft. by 5 ft., £1,500 each; other planing machines, £1,050, £1,100, £1,300; a "B" type vertical milling machine, £250; a "Herbert's" No. 9 double-geared horizontal milling machine, £420; horizontal "R S" type boring, drilling, milling, and tapping machine, £750; 18 in. centres lathe, £580; 12 in. centres lathe, £620; two 12 in. centres lathes, £360 and £410 respectively; two nearly new planing machines, £900 each, and a third, £500; 3-cwt. pneumatic hammer, 9 in. cylinder, £700; 9½ in. centre lathe, £500; automatic gear-cutting machine, £750; three 2-ton electric travelling cranes, £570, £610, and £610 respectively.

In view of the large number of motor ships being built in this country, the two-cycle Diesel marine engine has particular interest as being the first reversible Diesel marine engine of any size that has ever been exhibited in England. In 1902 Messrs. Sulzer Bros. first took up the manufacture of this engine, and since that date have supplied 900,000 h.p. in sizes from 20 to 4,000 b.h.p. The engine which Messrs. Sulzer are exhibiting at the Crystal Palace Great Victory Exhibition is a four-cylinder, two-cycle engine, the dimensions of the working cylinders being 340 m/m (13.38 in.) diameter by 540 m/m (21.26 in.) stroke, with a double-acting scavenge pump and 3-stage h.p. compressor, driven direct from the main crankshaft. The engine develops 410 b.h.p. at 200 revs. per minute, and has a fuel consumption of .44 lbs. per b.h.p. hour, with liquid fuel of a calorific value of not less than 18,000 B.T.U.'s per lb. Messrs. Sulzer have already granted licences for the manufacture of these marine engines in this country to Sir W. G. Armstrong, Whitworth & Company, Limited; William Denny & Brothers, Limited, and Alexander Stephen & Sons, Limited

The scarcity of manganese which seemed to be threatening the United States earlier in the year is not probable now. The output of ferro-manganese has been steadily mounting each month until in June it reached 26,265 tons, according to the blast furnace reports of "The Iron Age," which include an estimate of the electric furnace output. The average for the second quarter is 5,300 tons per month larger than that for the first quarter, or 23,318 tons against 18,049 tons per month. The imports are also growing, those for May having been nearly 4,000 tons, the heaviest in the last seven months, and exceeded only three times in 1919. Ore imports are also increasing, having been twice as large in April and May as in the first quarter, or 91,674 tons for the two months, against 44,539 tons for the three. Thus the rate to June has been over 27,000 tons per month, or very nearly equal to the 1919 movement. If the domestic production of ferro-manganese continues at the present rate, and the imports equal the average thus far maintained, the steel industry's needs for 1920, assuming a production of 44,000,000 tons of ingots and castings for the year, will easily be met

In connection with the British Empire Exhibition, which is to be held in London in 1923, the Imperial Government have agreed to give a guarantee of £100,000 against any loss which may result. The Government contribution is subject to the following conditions:—(1) That the guarantees from other sources shall not be less than £500,000. (2) The Government to have the right to approve the choice of a general manager. (The appointment of Mr. Ulick Wintour, C.B., has been approved.) (3) The executive council of the exhibition to be enlarged and strengthened, the final list to be approved by the Board of Trade. (4) All regulations affecting the participation of the Dominions, India, the Colonies and Protectorates, and the entry of British exhibitors to be approved by the Exhibitions Division of the Department of Overseas Trade. These conditions have been complied with. The Prince of Wales, in his letter to the Lord Mayor read at the Mansion House meeting in June, expressed "the earnest hope of the committee that it may be possible to obtain for so worthy a cause guarantees of at least £1,000,000." No general appeal has yet been made to the great commercial institutions of the country. That will come later; but a Guarantee Fund Committee has been formed. The Committee is composed of Sir R. V. Vassar-Smith (chairman), Mr. E. Clifton Brown, Mr. G. C. Cassels, the Hon. Sir W. H. Goschen, Sir Herbert Hambling, Sir Charles C. McLeod, and Mr. C. Freeman Murray (British Empire League).

In discussing before the British Association some phenomena of industrial fatigue, Professor F. S. Lee, of the United States Public Health Service, said that the hourly output in physiological operations was practically always increased by a diminution of hours, but the effect on the total output depended on the balance between increased productive power and lessened hours of work. In the very severe tasks of the millmen in the tinplate manufacture Vernon found the total output to be 8.3 per cent. greater than in the six-hour than in the eight-hour shift. But this lent no support to the argument for a universal six-hour day. What period, indeed, represented the most nearly universal optimum for a working day was still an open question. A comparison of the diurnal curves of the output of the eight- and ten-hour factories investigated by the Public Health Service showed that a conspicuous feature of work on the eight-hour plan was its steady maintenance of output, in contrast to the fluctuations of output of the ten-hour plan. Each added contribution of observation and experiment appeared more and more to support the view that from the standpoint of physiological essentials the optimum working period was comparatively short but varied in duration with the kind of work performed. Eight hours was probably too long for certain kinds of work and too short for others. A universal eight-hours day would be unscientific. Recess periods during the working spell nearly always resulted in increased hourly output and frequently in increased output for the whole day.

It is officially announced that the negotiations between the directors of Stewarts & Lloyds, Limited, and Alfred Hickman, Limited, for the amalgamation of the two companies have been concluded. The shareholders of the latter company are to be offered for every £1 share held one £1 deferred share of

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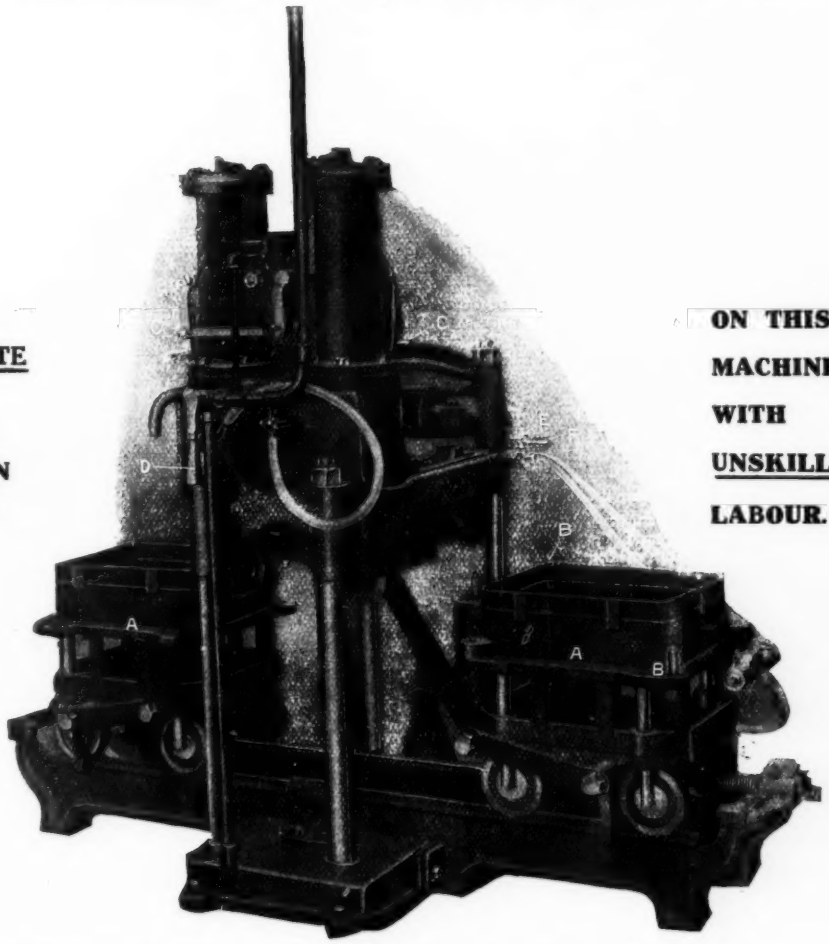

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Stewarts & Lloyds, Limited, and (subject to audit) a sum in cash equal to 7s. 6d. per share. The offer is conditional on ratification by the holders of 80 per cent. of the shares. Taking the value of Stewarts & Lloyds deferred share at its last price, namely, 47s. 6d., the amount which the company proposes to pay for each share of Alfred Hickman, Limited, including the sum of 7s. 6d. in cash, is equivalent to 55s. Stewarts & Lloyds, Limited, were registered on March 15, 1890, under the title of A. & J. Stewart and Clydesdale, Limited, to take over the business of Andrew & James Stewart, Limited, iron and steel tube manufacturers and ironfounders, at Coatbridge and Glasgow; Messrs. Stewart Brothers, iron and steel tube manufacturers, Coatbridge; and the Clydesdale Iron and Steel Company, of Mossend, near Glasgow. Early in 1898, the kindred business of Messrs. James Menzies & Company, of Glasgow, was taken over, and the name changed to A. & J. Stewart & Menzies, Limited; while early in 1903, following the absorption of the business of Lloyd & Lloyd, Limited, the title of the company was altered to Stewarts & Lloyds, Limited. The capital of the company is £3,182,500. Alfred Hickman, Limited, were registered on August 26, 1882, as the Staffordshire Steel and Ingot Iron Company, Limited; but in 1897, in connection with an increase in the capital, the title was altered as above. The authorised capital is now £1,000,000 in £1 shares.

THE reconstruction and extension of the iron and steel plant of the Consett Iron Company, Limited, and the erection of additional by-product plant is still receiving consideration. Two additional turbo-blowers have been ordered for the blast furnaces, which will be utilised on the existing plant, and will also be suitable for the proposed new plant. Representatives of the company have visited America in connection with proposals for reconstruction of the iron and steel works, and also the erection of additional coke and by-product plant. A new coal winning has been commenced near to Consett, and will be known as the Victory Pit. Steps are being taken to assist housing by the erection of houses by the company, and further by lending money to local authorities on housing bonds. The company has also erected at Consett a temporary hostel to accommodate 118 men, and it is fully occupied. Mr. C. A. Cochrane has been elected to fill the vacancy on the directorate caused by the death of Mr. F. Stobart. Mr. M. Fenwick, who agreed to accept the position of chairman of directors (following on the death in 1914 of Mr. C. W. C. Henderson), did so on the understanding that he would be released from the position at an early opportunity. He has, however, continued in the position during the whole of the war, and now resigns the chairmanship. Mr. C. D. Smith has been elected to take his place. Mr. Ainsworth's place on the board of the Orconera Company as a managing director has been taken by Mr. E. J. George, the present general manager of the Consett Iron Company. The English directors of the Orconera Company were this year able to visit the mines in Spain for the first time since 1914, and made a full inspection of the mines and properties of that company. Mr. C. A. Cochrane has been elected a director of the Consett Spanish Ore Company, Limited, to fill the vacancy caused by the death of Mr. F. Stobart.

Applications for Patents.

Ball, E. B. Centrifugal casting-machines, and moulds therefor. 22,877. August 3.

Bansen, H. Hearth smelting or annealing furnace. 21,079. July 12. (Germany, December 2, 1918.)

Bardeen, H. A. Restoring strength of steel. 22,066. July 23.

Beardsley, E. O. Moulding-machines. 17,713. June 29. (United States, December 22, 1919.)

Beazley, T. A., Fellowes, F., and Dunlop Rubber Company. Moulding-apparatus. 17,936. June 30.

Belledin, Sir V. E. Locknuts. 23,261. August 7. (Belgium, August 7, 1919.)

Chovin, A. Tilting-devices for metallurgical, etc., vessels. 20,111. July 9. (Germany, September 10, 1918.)

Diefenthaler, A. Production of grey cast-iron. 19,988 July 8. (Germany, May 9, 1916.)

Dobblestein, O. Production of briquettes. 20,014. July 9. (Germany, March 24, 1914.)

Döhle, F. Process for casting by compressed air. 18,184. July 2. (Germany, November 22, 1917.)

Döhle, F. Process for casting pipes, etc. 18,185. July 2. (Germany, December 2, 1918.)

Döhle, F. Moulds and core-pieces. 18,186. July 2. (Germany, April 8, 1919.)

Döhle, F. Cores for metal moulds. 18,187. July 2. (Germany, December 29, 1919.)

Döhle, F. Process for casting brass, etc. 18,188. July 2. (Germany, December 27, 1919.)

Döhle, F. Process for casting metal. 18,189. July 2. (Germany, January 26, 1918.)

Gillespie, W. M. Manufacture of finely-divided metals and alloys. 16,742. June 21.

Harris, F. W. Restoring strength of steel. 22,066. July 23.

Hines, L. H. Foundry hoppers. 17,842. June 30.

Krupp, Akt.-Ges., F. Process for producing low-carbon ferro-chromium. 17,388. June 25. (Germany, July 27, 1916.)

Krupp, Akt.-Ges., F. Process for producing low-carbon ferro-chromium. 17,392. (Germany, October 3, 1916.)

Krupp, Akt.-Ges., F. Process for producing low-carbon and low-silicium ferro-chromium. 17,393. June 26. (Germany, January 11, 1918.)

Mansfeld'sche Kupfer und Messingwerke. Chill moulds for casting metals. 20,610. July 10. (Germany, January 18, 1918.)

McKnight, C. Methods of casting metal. 17,772. June 29. (United States, December 20, 1919.)

Manchester Furnaces, Limited. Furnaces for heat-treating materials. 22,568. July 29

Metallbank & Metallurgische Ges. Furnace for annealing metals. 20,156. July 9. (Germany, March 14, 1919.)

Metallindustrie Schiele & Bruchsaler. Production of aluminium castings. 18,712. July 5. (Germany, December 16, 1918.)

Metallindustrie Schiele & Bruchsaler. Production of aluminium castings. 19,720. July 8. (Germany, March 19, 1919.)

Neil, J. M. Moulding-boxes, etc. 17,142. June 24.

Pickersgill, H. Method of forming foundry core-boxes. 16,950. June 22.

Piercy, J. W. Handling furnace slag. 16,922. June 22.

Piper, W. F. Machine for making moulds. 18,728. July 5. (United States, June 22, 1917.)

Plant, J. W. Method of electrically welding steel. 17,135. June 24.

Rautenbach, R. (firm of). Casting aluminium pistons. 18,068. July 2. (Germany, January 24, 1919.)

Rennison, F. T. Gas-fired furnaces. 17,871. June 30.

Teeter, R. J. Moulding apparatus. 21,395. July 15. (United States, July 16, 1919.)

Thompson, A. E., and Thompson, Limited, J. Covers for close annealing. 17,255. 17,266. June 25.

Uhlmann, A. Process for casting metals, etc. 16,864. June 22. (Germany, December 27, 1918.)

Wade, H. (*Byers Company*). Manufacture of wrought iron. 21,911. July 21.

Wade, H. (*Byers Company*). Manufacture of wrought iron. 22,005. July 22.

Windhausen, F. Casting metals. 19,581. July 8. Germany, December 8, 1913.)

Windhausen, F. Casting metals. 19,582. July 8. Germany, November 15, 1915.)

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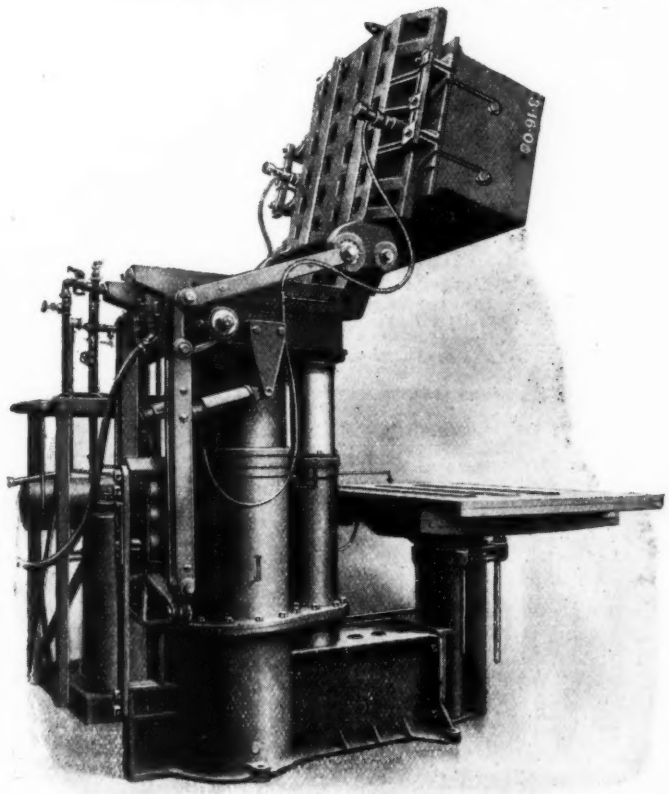
TABOR PATENTS.

Patent Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Moulding Machine.

Suitable for the most economical production of any repetition work, from the smallest up to a load of 12,000 lbs. at 100 lbs. air pressure, covered by a range of five machines.



Mould having been rammed, box and pattern in act of being rolled over on to levelling table on other side of machine.

Jar rams the box in less than one minute.

Rolls the mould over, draws and raps the pattern.

Rolls the pattern back ready for the next box.

COMPLETE MECHANICAL OPERATIONS OF THE MACHINE NOT EXCEEDING FOUR MINUTES.

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Personal.

THE late Mr. S. Lister, engineer and ironfounder, of Bradford, left £12,457.

THE late Mr. M. Allen, engineer, of Stretford, Lancs., left estate of the gross value of £31,066.

MR. S. J. PASSMORE, of Messrs. Langton & Passmore, has joined the board of Eltringhams, Limited.

THE late Mr. J. Scott, at one time chief engineer of the Consett Iron Works, left estate valued at £21,679.

A BUST of Sir Henry Bessemer has been installed in the McKinley Memorial Building at Niles, Ohio, U.S.A.

THE late Dr. Bernard More, the well-known metallurgist, for many years a director of the Mond Nickel Company, Limited, left estate valued at £44,653.

THE late Mr. P. J. Tucker, of Messrs. P. J. Tucker & Company, ironfounders and engineers, Hull, left £11,458.

THE late Mr. F. Bowes, managing director of Richard Hill & Company, Limited, Middlesbrough, left estate of the gross value of £18,553.

ESTATE of the value of £13,420 has been left by the late Mr. R. Hyndman, hardware merchant, of Birmingham.

MR. R. S. ROWELL has been elected a director of R. & W. Hawthorn, Leslie & Company, Limited, Newcastle.

MR. E. H. GARY, chairman of the United States Steel Corporation, is paying a short visit to this side of the Atlantic.

LORD PIRRIE has been elected a director of D. & W. Henderson & Company, Limited, in place of the late Dr. John Inglis.

THE late Mr. B. Swift, of Messrs. Swift Bros., Owlerton Bridge Rolling Mills, Sheffield, left estate valued at £81,219.

SIR WILLIAM THOM, of Yates & Thom, Limited, has been elected a director of the Iron Trades Employers' Insurance Association.

THE late Mr. Wilson Worsdell, who for 20 years controlled the locomotive construction of the North-Eastern Railway, left £11,103.

MR. ROBERT JONAS, JUN., has been appointed chairman of Jonas & Colver, Limited, steel manufacturers, Sheffield, in place of the late Mr. B. W. Winder.

MR. J. E. BAKER, chairman of the Sheffield and District Engineering Trades Employers' Association, has been elected a director of Davy Brothers, Ltd.

COL. SIR CHARLES ALLEN, chairman of Henry Bessemer & Company, Limited, and of the Ebbw Vale Steel, Iron and Coal Company, Limited, left £98,593 gross and £87,855 net.

MAJOR P. D. THOMAS has been elected a director of the Neepsend Steel and Tool Corporation, Limited. Mr. W. P. Donald, of Barnsley, has been appointed secretary of the company.

DR. J. S. FLETT, F.R.S., has been appointed by the President of the Committee of Council for Scientific and Industrial Research to be Director of the Geological Survey and Museum.

MR. J. E. FURNESS, of Halifax, Nova Scotia, has retired from the board of Furness, Withy & Company, Limited, and the directors have elected Sir Osborn G. Holmden to fill the vacancy.

MR. CHARLES WIGGINS, a director of Hanson, Brown & Company, Limited, iron, steel, etc., merchants, of Middlesbrough, has been appointed to the Commission of the Peace for the North Riding of Yorkshire.

MR. W. F. BEARDSHAW, of the Baltic Steel Works, Sheffield, has been appointed Finnish Vice-Consul for the Eastern part of the West Riding, and Mr. P. W. Lee, of Arthur Lee & Sons, Limited, Attercliffe, Honorary Vice-Consul for Portugal.

MR. W. LEMMON, departmental manager at the works of Reyrolle & Company, Limited, Hebburn, who is leaving for Australia, where he will be the firm's representative, has been the recipient of a presentation from the officials and men.

MR. E. H. CUTHBERTSON, who has been a director of the Sheffield Steel Products, Limited, since its early days, has tendered his resignation. Mr. I. Hemmings, who has an extensive knowledge of the steel trade, has been co-opted to fill one of the vacant seats on the board.

MR. W. BOYD, general manager at Messrs. Swan, Hunter and Wigham Richardson & Company's shipyard, who is leaving after seven years to take up the position of managing director of Workman, Clark & Company, Limited, has been the recipient of a presentation from the officials and men.

MR. A. SPENCER, a director of the Metropolitan Carriage, Wagon & Finance Company, Limited (joint vice-chairman), Metropolitan-Vickers Electrical Company, Limited, and George Spencer, Moulton & Company, Limited, has been elected a director of Vickers, Limited, to fill the position recently vacated by Mr. Dudley Docker.

MR. D. ARMITAGE, who has been connected with the company for many years, has been elected a director of William Firth, Limited, iron, steel and machinery merchants, Leeds. Mr. B. A. Beach, who has also been made a director, was, previous to the war, engaged with the South Kirkby, Featherstone and Hemsworth Collieries, Limited.

M. CHARLES LAURENT, President of the French Union of Metallurgical and Mining Industries, has been appointed French Ambassador in Berlin. He represented the Association of Electrical Plant Manufacturers in the Union, and his place in the presidential chair has been taken by M. Gabriel Cordier, President of the Association of Hydraulical Engineers.

MR. J. RIDER has been elected by the directors of Richard Hill & Company (1899), Limited, Middlesbrough, as managing director in succession to the late Mr. F. Bowes. Mr. Rider was for several years manager of the Cleveland Wire Mills of Dorman, Long & Company, Limited, and afterwards for five years manager to Richard Johnson & Nephew, Limited, of Manchester.

MR. M. MANNABERG, managing director of the Frodingham Iron and Steel Company, Limited, has resigned. Mr. Mannaberg is a vice-president of the Iron and Steel Institute and a member of many scientific and technical bodies. He has practically given his life to the iron and steel trade, and although he has retired, at the age of 63, from administrative work, he purposes to devote the remainder of his life in an honorary capacity for the good of the industry. The new managing director of the Frodingham Iron and Steel Company, Limited, is Mr. James Henderson, who commenced his career at the same works over 30 years ago as an analytical chemist, and became in turn mill manager, steel works manager, joint general manager, and director.

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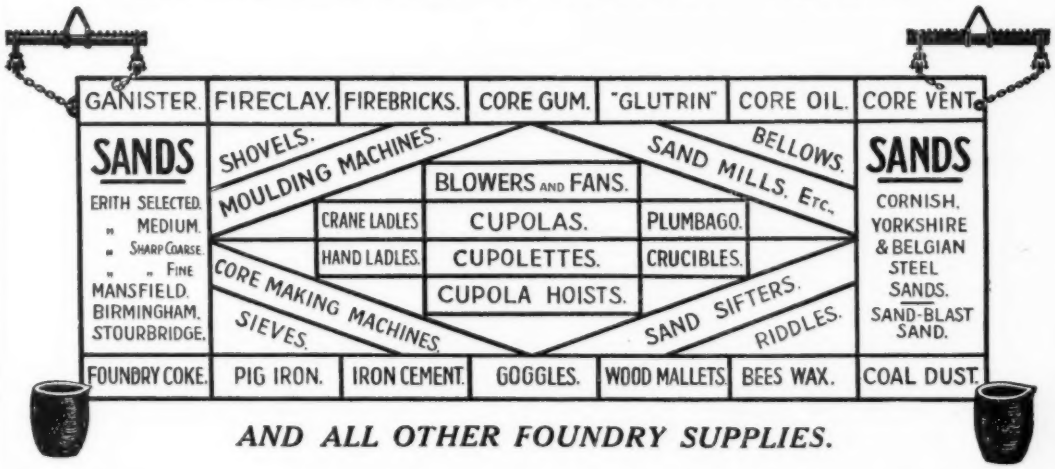

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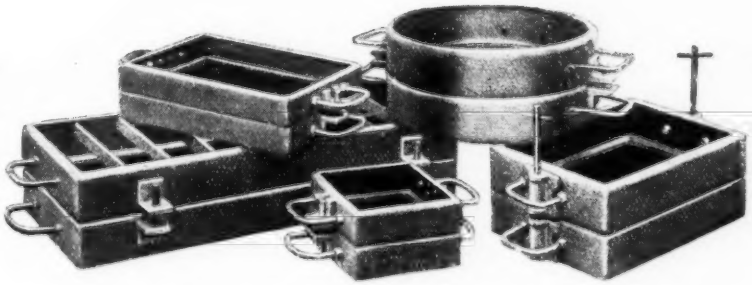

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Deaths.

THE death has taken place at Northcote, Uddingston West, of Mr. P. Cuningham, J.P., in his 67th year, general manager for Stewarts & Lloyds, Limited, Clydesdale Works.

THE death is announced of Mr. E. Parry, which took place at his residence in Leamington. Mr. Parry, who was 76 years old, was a well-known civil engineer. He was responsible for the work of carrying the Great Central Railway through Nottinghamshire to Leicester.

MR. B. W. WINDER, J.P., has recently died at his residence, Ceylon House, Westbourne Road, Sheffield. Mr. Winder, who had been seriously ill for some months past, was in his 62nd year. He had devoted practically the whole of his life to the steel industry of Sheffield, and had achieved great success as a metallurgist. After finishing his education in Sheffield, he became connected in 1874 with the firm of Jonas & Colver, with which concern he spent the rest of his life. After spending a short time in the offices he entered the works, and gained a practical training in steel making. He took up the chemical side of the industry, following it with great assiduity at a time when education in this branch was on a very limited scale. He was soon works chemist, and may be regarded as one of the pioneers in the application of chemistry to steel making. He was one of Sheffield's leading experts in this side of the industry, possessing a very special knowledge of tool steels, in the manufacture of which his firm holds a high position. He became works manager, a director of the company, and on the retirement of Sir Joseph Jonas, in 1918, chairman. He travelled extensively on the business of the firm, visiting America and Canada several times, as well as various parts of the Continent of Europe. At the Brussels Exhibition, about ten years ago, he had the distinction of being chosen as one of the three English judges of the steel section. He was a director of the engineering firm of Smith & Coventry, Limited, of Manchester. A few years ago, in recognition of his work for the Sheffield University, the degree of Master of Metallurgy was conferred upon him, and, when the faculty of metallurgy was founded, he was made a member of it.

AMERICAN STANDARDS. — The "Journal of Industrial and Engineering Chemistry" announce that the Bureau of Standards will continue to prepare and issue standard samples. It is earnestly requested that all users of standard samples refrain from any unnecessary waste of the material, and that educational institutions limit their use strictly to primary standardisation and to advanced research. A list of the standard samples issued by the Bureau, together with charges and ordering and shipping regulations, is given in the Bureau of Standards "Supplement to Circular 25," which will be sent upon application. In the future, standard samples will be issued only direct to users. This policy has been adopted to avoid, as far as possible, any chance of contamination or mixing of samples. Such chemical supply houses as have in the past carried a limited supply of certain standard samples for the accommodation of their customers can still render them service by remitting their orders with the proper fees to the Bureau for shipment. The following samples are in preparation: Sample 45*a*, Melting Point Copper, and Sample 13*b*, a renewal of the 0.6C Basic Open Hearth Steel, will be issued on or before June 15. Sample 50, a new chrome (3.6 per cent.)-tungsten (17.5 per cent.)-vanadium (0.75 per cent.) steel sample, will be issued on or before July 1. Sample No. 32*a*, a renewal of the chrome-nickel-steel, will be issued on or before August 1. Samples 23*a* 0.8C Bessemer Steel, and 51, a new 1.2C Electric Furnace Steel, will be issued on or before September 1. Sample No. 10*c*, a renewal of 0.4C Bessemer Steel, has been ordered and should be ready by October 1.

New Companies.

Swainson Pump Company, Limited.—Capital £10,000 in £1 shares.

Sir W. G. Armstrong Whitworth Aircraft, Limited.—Capital £20,000 in £1 shares.

W. and P., Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers.

North British Premier Electric Welding Company, Limited.—Capital £40,000 in £1 shares.

Robert Hornby & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers.

New Eagle Foundry Company, Limited. — Capital £3,000 in £1 shares. Registered office: Birkby Street, Birmingham.

Acme Metal Works, Limited.—Capital £5,000 in £1 shares. Registered office: 1 and 3, Lefroy Road, Shepherd's Bush, W.

Derwent Metals, Limited. Capital £100,000 in £1 shares. Registered office: Charter House, 10, Sandhill, Newcastle-on-Tyne.

South Wales Electric Welding Company, Limited.—Capital £5,000 in £1 shares. Registered office: 236, Bute Street, Cardiff.

Clissold Foundry Company, Limited.—Capital £5,000 in £1 shares. Registered office: Clissold Passage, Spring Hill, Birmingham.

North London Engineering Company, Limited.—Capital £15,000 in £1 shares. Registered office: 109, Cobbold Road, Willesden, N.W.

Rockingham Foundry Company, Limited. — Capital £5,000 in £1 shares (2,000 preference). Registered office: Coton Road, Nuneaton.

Gerritsen, Limited.—Capital £79,000 in £1 shares, to carry on the business of machinery merchants. Registered office: 45, Tooley Street, S.E.

Heard Brothers, Limited.—Capital £20,000 in £1 shares, to carry on the business of engineers. Registered office: Westcombe, Bideford.

Lombard Rim & Tube Company, Limited.—Capital £20,000 in £1 shares (6,500 preference). Registered office: Lombard Street, Birmingham.

Hydro-Electric Development Company, Limited.—Capital £50,000 in £100 shares. Registered office: 12, Nicholas Lane, Lombard Street, E.C.

Marine & Mechanical Electric Welding Company (Cardiff), Limited.—Capital £20,000 in £1 shares. Registered office: 3, Lloyd's Avenue, E.C.

E. L. Reynolds, Limited. — Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: 46, Stanley Street, Southport.

Hughes and Watts, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: Woodchurch Road, Birkenhead.

South Wales Colliery Tram Works & Engineering Company, Limited.—Capital £5,000 in £1 shares. Registered office: 6, High Street, Pontypridd.

Crucible Steels, Limited.—Capital £5,000 in £1 shares. First directors: S. K. Wright and H. B. Hicking. Registered office: 65, Henry Street, Sheffield.

Steel-Nickel Process Syndicate. Limited.—Capital £6,000 in 1s. shares, to acquire inventions of H. Jones. Directors: J. T. John, D. Thomas, and D. Roberts.

Clarkson Brothers, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: Olympia Garage, Ings Road, Wakefield.

Dominion Malleable, Limited.—Capital £20,000 in £1 shares, to carry on the business of ironmasters. Registered office: Etna Works, Rolfe Street, Smethwick.

M. Squire & Sons, Limited.— Capital, £22,500 in £1 shares (7,500 preference), to carry on the business of engineers. Registered office: Tuly Street, Barnstaple.

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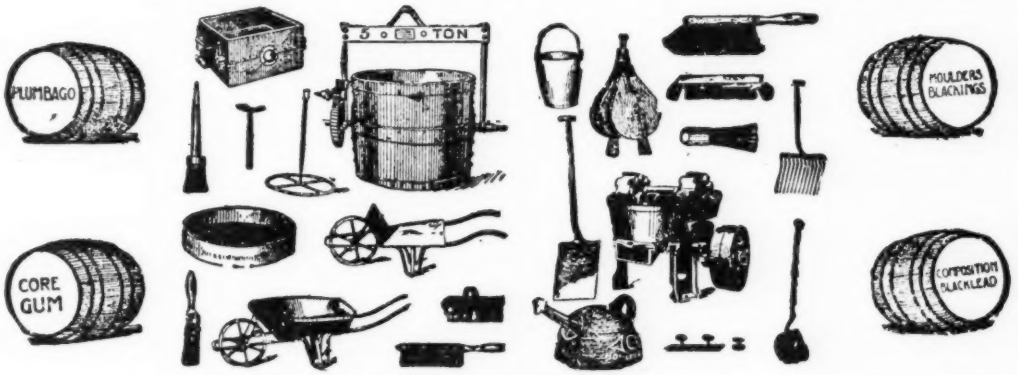

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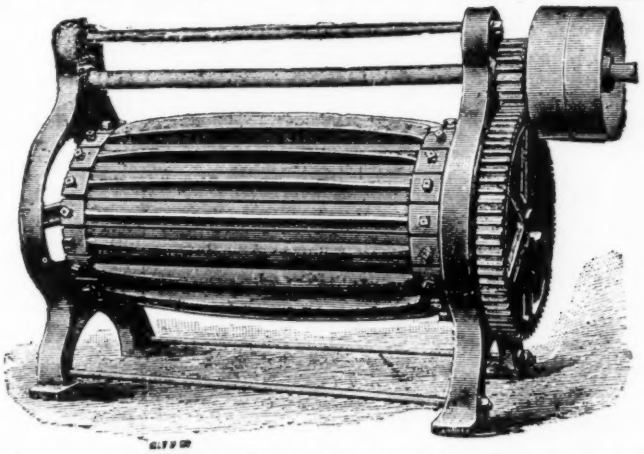

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John King & Company (Leeds), Limited. — Capital £20,000 in £1 shares, to carry on the business of engineers. Registered office: West Bar Chambers, Boar Lane, Leeds.

P. Pike & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: The Garage, Alphington Street, St. Thomas, Exeter.

James Shortland & Company, Limited. — Capital £15,000 in £1 shares, to acquire the existing business of nail and tack manufacturers. Registered office: 49, Park Street, Wishaw.

Joseph Robinson & Company, Limited. — Capital £50,000 in £1 shares, to carry on the business of engineers. Registered office: Springfield Lane Ironworks, Senior Street, Salford.

Dexter & Company (High Wycombe), Limited. — Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: The Foundry, Queen's Road, High Wycombe.

Fyfe Lumsden, Limited.—Capital £12,000 in 11,500 "A" shares of £1 and 10,000 "B" of 1s., to carry on the business of engineers. Registered office: Lane Ends, Eccles, near Manchester.

Garnett, Tucker & Company, Limited. — Capital £5,000 in £1 shares, to carry on the business of electrical and mechanical engineers. Registered office: 133, West Campbell Street, Glasgow.

Vulcan Arc Welding & Transport Company, Limited.—Capital £10,000 in 1,000 founders' and 8,900 ordinary of £1, and 2,000 employés of 1s. Registered office: 3 and 4, Harrington Street.

Fine Castings, Limited.—Capital £25,000 in £1 shares, to acquire from S. Milson certain hereditaments and premises at Fishponds, Bristol. Registered office: 24, Baldwin Street, Bristol.

Yardley & Carter, Limited.—Capital £12,000 in £1 shares (4,000 preference), to take over the business of a japanner, galvaniser, etc., carried on at Willenhall Street, Darlaston, as Yardley & Carter.

Sheffield Hollow Drill Steel Company, Limited.—Capital £20,000 in £1 shares (2,000 preferred). Directors: C. P. Morrison and H. Pearson. Registered office: 14-15, Orchard Chambers, Church Street, Sheffield.

Central Electrical Engineering Company, Limited.—Capital £100 in £1 shares, to acquire the business carried on at 26, Paradise Square, Sheffield, as the Central Electrical Engineering Company. Director: J. H. Horner.

Robert Semple, Limited.—Capital £30,000 in £1 shares, to acquire the businesses of R. Semple, consulting and manufacturing engineer, Glasgow, and the Blackhall Engineering Company, Limited, Glasgow. Registered office: 179, West George Street, Glasgow.

Petrie & McNaught, Limited.—Capital £300,000 in £1 shares (100,000 8 per cent. cumulative preference), to take over the business of engineers and machinists carried on at Rochdale, Lancashire, by John Petrie, Jun., Limited. Secretary: W. Hoyle. Registered office: River Street Ironworks, Rochdale.

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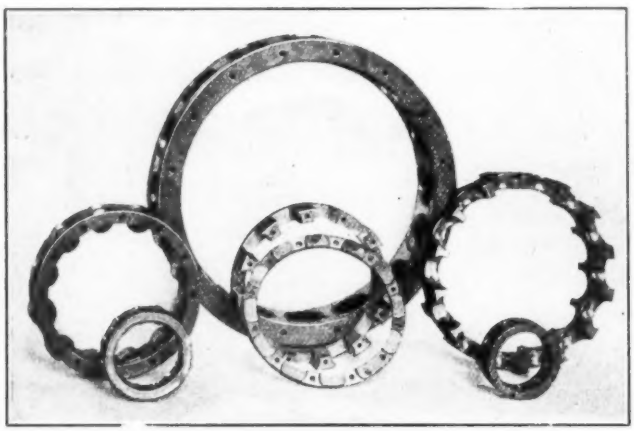

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No. 4 forge	12 10 3
No. 3 foundry	13 17 6
No. 2 foundry	13 19 6
No. 1 foundry	14 1 6
Basic	12 5 0
Northamptonshire—	
No. 4 forge	11 18 0
No. 4 foundry	11 19 0
No. 3 foundry	12 0 0
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Ferro-Tungsten.—75/80%, 3/3.
Ferro-Molybdenum.—70/80%, Mo., 9/6.
Ferro-Vanadium.—35/40%, Va., 60/-.
Metallic-Manganese.—98/99%, carbonless, 4/-. (All per lb.).
Ferro-Phosphorus—20/25%, P. £50 0 0.
Ferro-Chrome.—4/6%, car., £39 0 0.
Ferro-Chrome.—6/8%, car., £39 0 0.
Ferro-Chrome.—8/10%, car., £40 0 0.
Ferro-Chrome —Specially refined, basis 60% chr., max. 2% car., £95 0 0.
Ferro-Silicon.—45/50% Si., £22 0 0 d/d. at Sheffield Steelworks.
Ferro-Manganese.—80%, £37 loose, £37 packed. Export £15, according to destination. (All per ton.)

Copper

	£ s. d.	£ s. d.
Standard cash	95 2 6	95 7 6
Three months	96 7 6	96 12 6
Electrolytic	111 0 0	117 0 0
Tough	109 0 0	110 0 0
Best selected	105 0 0	107 0 0
Sheets	166 0 0	—
India	168 0 0	—
American electrolytic spot	119 10 0	—
Do. Oct.	—	—
Official average price cash, Aug.		94 1 0½
Do. Three months, Aug.		95 15 10
Do. Settlement, Aug.		94 0 0
Do. Electro, Aug.		114 0 5½
Do. B.S., Aug.		106 12 2½
Average spot price, copper, Aug		93 19 2
Do Electro, Aug.		116 18 1

Tin.

	£ s. d	£ s. d.
Cash	269 0 0	269 10 0
Three months	276 0 0	276 10 0
English	268 0 0	269 0 0
Bars	270 0 0	271 0 0
Refined	—	—
Straits	—	277 10 0
Australian		276 10 0
Eastern		288 15 0
Banca		272 0 0
Official average price, cash, Aug.		274 5 10
Do. Three months, Aug.		280 19 7½
Do. Settlement, Aug.		274 5 8½
Average spot price, Aug.		272 2 4½

Spelter.

	£ s. d	£ s. d.
Ordinary	30 10 0	40 0 0
Remelted	31 10 0	32 0 0
Hard	25 0 0	26 0 0
Electro 99.9	46 0 0	—
English	41 0 0	41 10 0
India	33 0 0	33 10 0
Zinc dust 92 94%	85 0 0	90 0 0
Do. English	—	—
Zinc ashes, per cent. 70%	8 10 0	9 0 0
Official average price, Aug.		41 19 6½
Average spot price, Aug.		41 4 5

Lead.

Soft foreign (net)	36 10 0
English	38 10 0
Official average price, Aug.	36 8 10½
Average spot price, Aug.	36 5 11½

Antimony.

	£ s. d	£ s. d.
English regulus	52 0 0	—
Chinese	46 0 0	47 0 0
Crude	40 0 0	—
Ore		Nominal.

Aluminium.

Virgin Metal 98/99—, per ton. 165 0 0

Phosphor Bronze.

Ingots.	Per ton.
Alloy No. I. or II.	—
III., IV., or V.	—
IV. or VII	—
VIII.	—
XI.	—
Cast Strips and Ingots	—
Castings.	**Per lb.**
I. or II.	—
III., IV. or V.	—
IV. or VII.	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
,, Cored Bars	—

Delivery 2 Cwt. free to any town.
10 per cent. Phosphor Copper £162
15 per cent. Phosphor Copper price B.S. £168
Phosphor Tin (5 per cent.) £30 above price of English Ingots.
Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAXELEY STREET MILLS, BIRMINGHAM.

*Chromium (Metallic).

98/99— purity, per lb. 7/-

*Nickel.

In cubes, 98/99— purity per ton £230 0 0

Nickel Silver.

	per lb.
Ingots for raising	1/7 - 2/-
Ingots for Spoons and Forks	1/7 - 2/-
,, rolled to spoon size	1/10 - 2/3

*Tungsten Metal Powder.

	per lb.
96/98— purity	3/10½

*Molybdenum Metal.

96/98— purity, per lb —

*Cobalt Metal.

97— purity, per lb. 0 13 0

Quicksilver.

75 lb. bottle 18 10 0
* Net, delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.	s. d.	£ s. d.
Steel scrap, heavy melting	—	207 6
Iron scrap cast (cupola metal)	—	222 0
(London f.o.b.).		
Heavy steel		—
Light ,,		—
Heavy cast		—

Steel Scrap.	Per ton. £ s. d.
Without Analysis—	
Heavy steel melting scrap	10 17 6
Steel planings, turnings and borings	7 10 0
Steel planings, turnings and borings mixed with wrought-iron or other material	8 10 0
Other classes of steel scrap, whether or not mixed	9 5 0
F.o.r. or in barge at nearest siding or wharf.	
With Analysis—	
Heavy steel melting scrap not over 0.04 per cent. p. and s.	—
Heavy steel melting scrap not over 0.05 per cent. p. and s.	—

Wrought-Iron Scrap.

	£ s. d.
(1) (a) W.I. plates and sections, not less than ¼ in. thick, reasonably clear of rivets, flanged ends, etc., suitable for shearing; cable scrap and chain scrap not less than ¼ in. dia.	11 10 0
(b) Heavy W.I. scrap not less than ¼ in. thick including horseshoes, rivets and bolts, and scrap therefrom	11 10 0
(c) W.I. scrap under ¼ in. thick, and all W.I. scrap not included in classes 1, 2 and 3	11 10 0
(2) Mixed W.I. scrap	10 0 0
(3) Wrought-iron planings, turnings and borings mixed with steel or other materials	8 10 0
(4) W.I. planings, turnings and borings	8 12 6

Cast-Iron Scrap.

	£ s. d.
Heavy ord., broken, between 1½ cwt. and 10 cwt. each	10 10 0
Heavy machinery, broken between 1½ cwt. and 10 cwt. each	10 15 0
Cold blast, broken, between 1½ cwt., and 10 cwt.	12 0 0
Ingot mould, unbroken	11 5 0
Do. broken, between 5 cwt. and 2 tons each	11 10 0
Do. between 1½ cwt. and 5 cwt. each	11 15 0
Railway chairs, whole or broken for remelting	10 5 0
Heavy lumps, not exceeding 2 tons each	9 17 6
Light	9 10 0
Burnt, broken ready for cupola	8 15 0
Burnt fire bars	9 5 0
Turnings and borings, for iron and steel makers	10 5 0

Old Metal.

	£ s. d.
London—	
Copper (clean)	80 0 0
Brass (clean)	52 0 0
Lead (less usual draft)	28 0 0
Tea lead	26 0 0
Zinc	23 10 0
New aluminium cuttings	120 0 0
Brazlery copper	70 0 0
Gunmetal	76 0 0
Hollow pewter	205 0 0
Shaped black pewter	105 0 0
(Above all d.d merchant's yard).	

Metallurgical Coke.

	£ s. d.
Durham and Northumberland—	
Blast furnace	3 2 9
Foundry	3 10 0
Lancs., Staffs., Yorks, Notts., Derbyshire, Lincolnshire and Midland Counties—	
Blast furnace	3 5 9
Foundry	3 17 9
F.o.t. at ovens.	